Vol. XI. APRIL, 1895. No. 12.

THE AMERICAN METEOROLOGICAL JOURNAL.

A MONTHLY REVIEW OF METEOROLOGY.

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EDITORIAL NOTE.

OUR next number opens the twelfth volume of the AMERICAN METEOROLOGICAL JOURNAL, which, in the eleven volumes that have been published, has done a work for American Meteorology that no other publication has attempted. In many respects the JOURNAL labors under great disadvantages, but in spite of these drawbacks, we feel that it has been able to keep up its old standard and to continue along the lines which its founders marked out. The twelfth volume begins with the prospect of increased support in the way of subscriptions and contributions than was given that which is now ending. It is hoped that the readers of the JOURNAL will be ready to appreciate the good features that may characterize the publication during the coming year, and may be as ready to overlook and to pardon any mistakes, in the publication of articles which may not particularly interest them, or in any other matter.

As we glance back over the contents of the volume which is now closing we note that the number of important articles has been large. The papers by Prof. Mark W. Harrington, on "Frequency of Amounts of Precipitation"; by Prof. F. H. Bigelow, on "Solar Magnetism in Meteorology"; by Mr. H. Helm Clayton, on "Changes in the Definitions of Clouds since Howard"; by Mr. A. Lawrence Rotch, on "The Meteorological Services of South America", and by Prof. Winslow Upton, on "Cyclonic Precipitation in New England," may be mentioned as being of general interest and value. The report by Mr. A. E. Douglass, on "Atmospheric Currents as seen through Telescopes," is a paper of far more than usual value, and is sure to attract attention wherever it is seen by meteorologists or astronomers. The question of the cause of the cyclones of the temperate latitudes,

which came into prominence shortly before Prof. Ferrel's death, and is one of extreme interest and importance, has been considered by Mr. W. H. Dines, of the Royal Meteorological Society, whose paper throws further light on the subject. One of the most attractive departments of meteorology concerns the study of the clouds, and in our July number we paid special attention to this matter, publishing in that issue Mr. Clayton's paper on the "Definitions of Clouds" referred to above; a review of Luke Howard's "On the Modifications of Clouds," also by Mr. Clayton, and a "List of Cloud Photographs and Lantern Slides," the latter presenting the international nomenclature of clouds and general information as to the characteristic features of clouds. In the December number we published one of the first full accounts of the meeting of the International Meteorological Committee that has appeared. Prof. von Bezold's important paper, "On Cloud Formation," which was originally published in German in "Himmel und Erde," was translated for this Journal by Mr. L. A. Bauer, a student of Prof. von Bezold's, and was printed in the September number with four illustrations, made for the Journal in Berlin. The Pole Star Recorder, a most interesting and valuable instrument in meteorological work, was described by Mr. S. P. Fergusson, of Blue Hill Observatory, in the June number. Prof. H. A. Hazen has contributed articles on subjects of popular interest, such as "Sunspots and Auroras," and "The Moon and Rainfall," and has continued his discussion of psychrometer problems, in which Dr. Nils Ekholm, of Stockholm has now joined. Other subjects considered have been the sea breeze, foreign studies of thunderstorms, meteorological records obtained by means of kites, storms of the Gulf of Mexico, etc.

In the Current Notes department we have given summaries of important papers published elsewhere, and general information on meteorological matters in this country, as well as in other lands. Our correspondence pages have contained letters to the Editor on various topics, and in the Bibliographical Notes we have published reviews of the most important publications that have appeared during the year, and complete lists of recent publications.

While we are constantly endeavoring to improve the Journal in every way, to make it more valuable to its readers, as well as

to make it more representative, we do feel that our eleventh volume has given its readers many very good things. The illustrations that have been published, while fewer in number than in some of the previous volumes, have been of special value in several cases. Among the latter we may mention the cloud photographs mentioned above, which accompanied the translation of Prof. von Bezold's article "On Cloud Formation"; the diagram of the Pickering Pole Star Recorder and of the records made by that instrument; the view of the Harvard College Observatory at Arequipa and of the Misti; the magnetic curves illustrating Prof. Bigelow's paper on solar magnetism, and the view of the atmospheric currents seen through the telescope at the Lowell Observatory, Flagstaff, Arizona.

Doubtless many of our readers have noticed that we have not published several of the papers whose titles we announced in our last April nnmber, and which we then stated that we expected to print in the course of the eleventh volume. The causes for these failures have, in most cases, been beyond our control. Several of the authors wished to hold their articles until they might be made more complete, and one or two have decided that the proposed papers would not be of sufficient value to warrant their publication. We regret the fact that some of our readers have been disappointed in this matter, and in order to avoid the possible risk of having this happen again, we shall at present make but one announcement of a paper that will be published in the coming volume. In the June or July number we shall present our readers with a valuable paper, by Messrs. George C. Whipple and Henry E. Warren, of the Massachusetts Institute of Technology, Boston, on the Thermophone, a new instrument invented by the authors for determining the temperature at distant or inaccessible places. This article will be illustrated. Having ourselves seen and tested the Thermophone, we feel sure that meteorologists, as well as physicists and scientific men generally, will be very much interested in this new instrument. Although we make but one announcement of proposed articles for the twelfth volume, we can assure our readers that we shall use our best endeavors to secure for the JOURNAL the most valuable contributions that can be obtained.

Certain of our readers have written us their opinion that the JOURNAL has given too much space to reprints from other publi

cations. In this matter we have endeavored to act in accordance with the best interests of the majority of our subscribers. A great many of the latter see no meteorological publication of any kind except this JOURNAL, and to such persons all the information presented here is fresh. On the other hand, those readers of the JOURNAL who see the current meteorological publications, must necessarily often find much in this JOURNAL which is familiar to them. This is a state of things which it seems to us impossible to avoid. Either we must print nothing but original matter, and thus satisfy the one class, or we must reprint more or less from other publications, and thus meet the wishes of the other class. That every reader should always be perfectly satisfied with each number we cannot expect, but we do what, according to the light we have, we think will best suit the majority of our readers. We are, however, always ready to receive suggestions as to changes and improvements. It is our hope that any readers of this JOURNAL, who are interested in its continuance and in its success, will freely communicate with us in regard to any such changes which they deem advisable for the best interests of the magazine.

In conclusion, we wish to refer, very briefly, to the advance of the teaching of meteorology in the United States during the past year. There can be no question that this science is destined to receive more and more attention in schools and colleges every year. We have no accurate or complete data at hand regarding the new courses in meteorology that have been introduced in educational institutions since we last wrote an editorial note, but we wish to refer to three notable steps in advance that have come more immediately to our attention. The University of California has laid out a very complete course in practical meteorology, as already outlined in this JOURNAL (Vol. XI., pages 192, 193). Harvard University announces, for the first time, a summer course in meteorology, to be given during the coming summer in Cambridge, Mass., beginning July 5 and lasting six weeks. The New England Meteorological Society, as announced in our April, 1894, number, has arranged a course of instruction in the use of the daily weather maps, especially adapted to the needs of school teachers. This course is given according to the plan outlined in the report of the Conference on Geography of the Committee of Ten on Secondary School Studies, and has

already been given to the school teachers in certain towns in New England. The plan has been favorably received by the school superintendents; the teachers who have attended the courses have been much interested in the work, and in many cases have at once introduced some work on the weather maps into their schools, as a result of this instruction. The prospect is very favorable for a large extension of this work next winter. In the schools of this country will come the great advance of meteorological instruction within the next few years, and in this work of giving the teachers systematic instruction in preparation for their teaching of the scholars, the New England Meteorological Society is certainly doing a most valuable pioneer labor which cannot fail to be productive of great good.

ROBERT DeC. WARD.

RECENT FOREIGN STUDIES OF THUNDERSTORMS: VI. SWITZERLAND.*

R. DeC. WARD.

THE systematic study of thunderstorms was begun in Switzerland in the year 1883, and has been regularly continued since then. The results have been published yearly in the *Annalen der Schweizerischen Meteorologischen Central-Anstalt* (Zurich). The report appears as an appendix to the *Annalen*, and includes the names of the stations and observers; a tabular statement of the date of the storms, the mean pressure, mean temperature, time of audible thunder, direction of movement, length of course, rate of movement in kilometers per hour, kind of precipitation, district covered, and remarks. Then follows a narrative account of the different storms, of the weather and pressure conditions, the damage done, etc. Special attention is paid to reports of hail, and to the damage done by hail. The earlier volumes present very few conclusions or theoretical generalizations, but more attention is given to this side of the subject in the later reports. Each report has several small charts, illustrating the tracks of the most interesting thunder-

* The previous papers of this series will be found in this JOURNAL, Vol. IX., pp. 532–541 (Great Britain); Vol. X., pp. 111–126 (Germany), pp. 178–184 (France), pp. 411–420 (Italy), and Vol. XI., pp. 364–368 (Russia).

storms, and in several cases there are full-page charts of especially important storms. These charts are clearly drawn, and, especially in the case of the larger ones, would afford a good basis for the minute study of the movement of these storms, and of the effect of the larger topographic features on their movement. The reports on thunderstorms were by G. Mantel, from 1883 to 1888, by F. Mauch in 1889 and 1890, and by Dr. Rud. Weth in 1891, the work being done under the direction of the *Schweizerische Meteorologische Central-Anstalt*, of which Dr. Billwiller is the head.

From the great body of material presented in these various reports we can extract only a few of the more interesting notes, although a careful study of the original accounts will well repay the thorough student of the subject. The general conditions of thunderstorm development in Switzerland are the presence of cyclonic depressions over northern Europe, high temperatures, southerly winds and secondary depressions over Switzerland. Unfavorable conditions as a rule are high pressure, clear and cool weather, and northerly winds. The winter thunderstorms are rare, and usually come in connection with warm winds and squally weather. They amount to little more than a few peals of thunder in general rainy conditions. The storms are classified as heat and as cyclonic thunderstorms. The heat thunderstorms are less violent and of less extent and duration than the cyclonic thunderstorms; they occur when the prevailing pressure is high, but the difference between the two kinds is quantitative rather than qualitative, for with sufficient and minute observations it is found that the heat thunderstorms occur in small secondary depressions, in the same way as the cyclonic thunderstorms.

In 1883,* the most interesting storms were those of April 20 and June 6, which moved from east to west; that of May 7, which began in the mountains north of Lake Brienz and spread northeast, northwest, and southwest, its front lines being sharply bent, almost closed, curves; that of July 5, which had a well-marked concave front, and that of July 10, which extended from Lake Constance on the north of the Alps to Lake Como on the south.

In 1884 the Meteorological Service secured the co-operation

* See this JOURNAL, Vol. III., 1886–1887, pp. 42,43.

of the *Schweizerische Hagelversicherungsgesellschaft*, from which accurate reports of the damage done by hail storms were received, thus materially increasing the number and the value of the observations. The activity of thunderstorms varies distinctly in different parts of their course; in some districts they are violent and accompanied by hail; in others they are very weak and do no damage. The valleys which give a favorable opportunity for local ascending currents, combined with the moisture due to evaporation from the lakes, are frequently found to be the places of origin of thunderstorms. This is clearly shown on June 13, 1884, when a small depression (1.5 mm.) formed in the early afternoon over one of the valleys and gave rise to a local thunderstorm. The close connection of thunderstorm activity and high temperatures is brought out in the following table of mean temperatures, departures from the normal daily mean temperature, and number of thunderstorn reports for July, 1884.

DATES.	4	5	6	7	8	9	10	11	14	15	16	17	18	19	20
Mean Temp.	22.1	22.6	19.4	19.2	20.0	21.1	19.8	20.4	25.2	23.8	23.8	24.5	20.6	15.4	14.4
Departures from normal daily mean.	+3.8	+4.3	+1.1	+0.8	+1.7	+2.7	+1.4	+1.8	+6.6	+5.2	+5.2	+5.9	+2.3	−3.3	−4.3
No. of Reports.	13	72	57	0	46	117	86	0	6	77	162	139	67	64	0

The direction of movement of the thunderstorms on days when there are no gradients, or very weak ones, is that of the winds 2,000–3,000 meters above the surface, as is shown by mountain and cloud observations. The volume for 1884 contains, in addition to the usual charts, four which show the pressure for every .5 mm. at 1 P. M. on four different days of thunderstorm occurrence. These isobars are for the pressure reduced to 500 meters above sea level, and show very distinct secondary depressions, not apparent on the ordinary weather maps, in connection with which the thunderstorms occurred.

Three interesting thunderstorms of the summer of 1885 are illustrated on special large charts in the report for that year. They were all typical summer *heat* thunderstorms, and occurred during the prevalence of an even pressure over Europe of 760 mm., the temperature being on the average 26° C. at 500 meters, and

the weather clear and calm. On June 9 the storms were fan-shaped, spreading out from one centre; on June 16 there were a number of small storms in action at the same time, but moving in different directions near one another, showing a tendency of the whole disturbance to split up. On June 30 there was a well-developed typical storm with heavy hail.

A curious storm is noted as having occurred on June 4, 1886. During the prevalence of northeasterly winds over Switzerland, a thunderstorm crossed the whole of the western part of the country between 3 and 8 P. M., moving northeast. It was apparently due to the mingling of a southwesterly current, which was blowing over France, with the northeasterly one prevailing over Switzerland, and moved northeast with the former current. About 8 P. M. the main storm met two smaller storms coming from the northeast with the northeasterly current. There was a general commingling of the three disturbances, which resulted in tremendous precipitation. On June 25 of the same year a thunderstorm was developed in a moist mass of air forced to rise on meeting the Alps, and moved up the valleys, in which it began, over the mountains at their head. Regarding a storm on June 29, M. Mantel writes: "There is no evidence of an influence of the topography. The storm moved uninterruptedly across valleys and hills with a difference in height of 400 meters." A further note on the effect of topography on the movement of thunderstorms is found in the report for 1887, in connection with a hailstorm on July 22. It is as follows: "This hailstorm is remarkable in many ways. It moves in the direction of the thunderstorm movement, that is, in the direction of the winds at the height of the thunder-clouds, in almost a direct line over a succession of deep valleys and over narrow as well as wide mountain ridges. In no case is there any indication that it tried to avoid a mountain or to follow a river or a lake valley. . . . The Linderberg seems to have attracted the hailstorm, not because it has deforested areas, for it is evident that these can have no effect on a thunderstorm which crosses heights up to nearly 1000 meters without any deflection, but because of the general law according to which heights attract thunderstorms on account of the stronger ascending currents which are produced ever them. As the conditions of the forest cover can, to a certain extent, influence this ascending current, because

a treeless mountain is more warmed than a forest-covered one, and therefore produces a more active ascending current, such forest covers can influence the thunderstorm probability and perhaps also the probability of hail. This influence, however, will probably always remain secondary to that which is due to the presence of the mountain itself.

"In the case of a large mountain mass projecting from the main chain outwards on to the lower level ground, towards which deep valleys ascend from all sides, the conditions for a strong ascending current of air are best fulfilled. It is, therefore, not to be wondered at that such a mountain mass becomes the place of origin of many summer heat thunderstorms and hail storms. Experience alone can show how far a careful reforestation can change these conditions."

On April 7, 1887, a well-developed thunderstorm moved across Switzerland from northeast to southwest, accompanying a secondary depression which crossed the district from northeast to southwest.

June 12, 1889, showed a very curious storm. While most thunderstorms move in more or less straight, while some move in crooked or curved courses, this one revolved around a central point in a contra-clockwise movement. The southeasterly direction of its front at noon changed to an easterly, northeasterly, and a northerly direction before 6 P. M. This remarkable movement was apparently due to the presence and progression of a tertiary depression over the district. On Aug. 19, 1890, a violent thunderstorm in the Joux valley was accompanied by a tornado, moving in a northeasterly direction. This tornado came from Oyonnax, department de l' Ain, France, and covered eighty kilometers in France and thirty in Switzerland. The width of the path was 200 – 1500 meters; the mean velocity 95 kms. an hour, or 26 ms. per second.

The last volume of the *Annalen* at hand is that for 1891, the report on thunderstorms being by Dr. Rud. Weth. In addition to the regular publication of the thunderstorm observations and accounts in the *Annalen*, there has recently been issued a report on the hailstorms of Switzerland, by Hess, based on the observations from 1883 to 1891.*

* HESS: *Die Hagelschlaege in der Schweiz in den Jahren* 1883 *bis* 1891 *und Theorie der Enwickelung und des Verlaufes der Hagelgewitter.* Beilage zum Programm der Thurgainschen Kantonsschule für das Schuljahr 1893–94. 1894.

This report is reviewed in the *Meteorologische Zeitschrift*, September, 1894 (71)–(72), and from this review the following brief summary is taken. Of the hailstorms, 41.4% occurred separately and locally, while 58.6% showed a distinct progression in a definite direction; 48% of the whole number of hailstorms came from the directions between west and southwest. The following table shows the percentages of storms coming from different directions during the nine years, 1883–1891:

W.	W. S. W.	S. W.	S.	S. E.	E.	N. E.	N.	N. W.
18	12	18	3	1	2	1	1	2.6

As a result of an examination of a chart of hail distribution it appears that hail is more common in damp valleys than on mountains, and more common on the windward side of mountains than on the leeward side. River valleys which run in the direction of movement of a hailstorm seem especially favorable to the formation of hail over them. Damp ground is favorable to hail formation, while forest covers are unfavorable. The influence in these cases is not necessarily shown in a cessation of the precipitation, but rather in the change in the nature of the precipitation. It appears that hail is noticeably deficient in valleys subject to the occurrence of fœhn winds.

Hailstones are regarded as drops of water suddenly congealed, whose form at the time of freezing determines the form of the hailstone. The thunder-cloud is believed to be in two parts, the lower of which is positively electrified, dark, and of a high degree of humidity, while the upper part is negatively electrified, light, and of a very low humidity. Between these two parts there is a constant electrical interchange. A condition of instability is necessary for the development of a hailstorm, which moves forward towards the side of instability, the ascending currents being in front, and the descending currents in the rear. The air brought down by the precipitation on the rear of the storm moves principally towards the front side, in order to replace the air which rises there. It is this wind, which can become very violent, that drives rain and hail on an inclined path towards the front of the storm, and thus may cause extended damage. The advancing wave of ascending air, crossing a region in which there is unstable equilibrium, may have very varying heights according to whether the ascending current is small or large,

moist or dry. Over moist valleys the clouds reach a greater height, and the products of condensation freeze. Over mountains the corresponding mass of air is less deep, not so warm, and dry, so there is less chance for hail. Forests in general have less moist air over them than treeless areas, and therefore we may expect little hail, or even rain, over them.

The material presented in the Swiss *Annalen* is very abundant, and the charts many and clear. As yet there has been no general summary of the whole body of data thus far collected, so that a very attractive field for work is open in this direction. Switzerland is probably the best possible place in which to study the effect of topography on thunderstorms, by reason of its high mountains and deep valleys. The systematic collection of thunderstorm data, carried on for twelve years, has made a thorough investigation of the phenomena of this class of atmospheric disturbances possible.

HARVARD UNIVERSITY, CAMBRIDGE, MASS., Feb. 1, 1895.

NOTE ON CROLL'S GLACIAL THEORY.*

PROF. W. M. DAVIS.

THE recent studies of Dr. Julius Hann, of Vienna, on the origin of cyclones and anticyclones, suggest an amendment to Croll's physical explanation of the climate of the glacial period, to which I desire to ask the attention of the Geological Society of Edinburgh.

In the first place, there appear to be three classes of facts calling for a common explanation; the extension of glaciers from various centres of snow accumulation; the extension of lakes in various interior basins; and the extension of rainfall over the now dry northern border of the Sahara. It is not yet directly demonstrated that all these extensions were synchronous; but they appear to have been so, as far as evidence now in hand can decide the case. In another respect, however, they are closely associated; this is in their all being winter products; indeed they may all be regarded as the

* Reprinted from the Transactions of the Edinburgh Geological Society. Vol. VII., 1894, pp. 77–80.

products of more wintry winters than we now have. Where snowfall is now heavy, more snowfall would produce glaciers; where interior basins are now arid, they are less parched under the winter storms than under the summer sun; where the northern Sahara is now dry and dusty in summer, it has some rainfall in winter, but not so much as formerly.

Croll's theory attempted to account for the first of these effects of more severe winters by his well-known astronomical theory; but he gave little attention to the processes by which snowy precipitation would be produced, and he had little to say about the other series of facts which may be reasonably associated with the former extension of glaciers and ice sheets. It seems, however, that all three series of facts follow closely from the conditions argued by Croll, and it is to the meteorological processes involved in their explanation that I will now turn.

Croll argued in favor of long and cold aphelion winters as the chief cause of the glacial period. In such winters, the rate of decrease of temperature from equator to pole would be rapid; the differences of atmospheric pressure thus determined would be strong, and the general circulation of the atmosphere in the winter hemisphere would be accelerated. It is well known that under existing conditions the winds of the winter hemisphere are stronger than those of the summer hemisphere. The difference in their strength would have been still greater during the conditions inferred by Croll as accounting for the glacial period. It is to the increased strength of the winds in the winter hemisphere, that I believe we may look for an effective cause of the several classes of facts already enumerated.

In the first place, consider the effect of a more active general circulation on the production of precipitation. Dr. Hann's discussions of the meteorological observations on the Sonnblick, the highest meteorological station of Europe, and of other Alpine stations, has led many to reconsider their former belief in the convectional origin of cyclones and anticyclones, those great travelling areas of whirling winds with centres of low or high pressure, by which the temperate zones are so strikingly characterized. There has been a general acceptance, provisionally at least, of Dr. Hann's explanation of the dynamic origin of cyclones and anticyclones, as driven eddies in the somewhat tangled movement of the general circumpolar winds. The

occurrence of more and stronger cyclonic and anticyclonic disturbances in winter than in summer favors this view. If convectional, the disturbances should have their maximum of frequency and intensity in summer, when the vertical temperature gradient is strongest, and when the absolute humidity of the air affords the greatest assistance to convectional movements by the more plentiful supply of latent heat liberated in the condensation of cyclonic clouds. If dependent on the strength of the general circumpolar winds, it is natural that the disturbances should be stronger in winter, when the general circulation is strengthened by the increased difference of equatorial and polar temperature then prevailing.

A longer and more severe winter would therefore provoke more active cyclonic processes, and it is entirely upon these that our snowfall in temperate latitudes depends. It is not correct to urge, as some geologists have done, that the snowfall for a glacial period requires an increased amount of vapor in the atmosphere, and hence a higher temperature. The essential thing is to cause a greater precipitation of snow, and this requires a greater activity of winter cyclonic storms, and a longer duration of the winter in which they occur. The local convectional rainfall of the doldrums, the violent intertropical cyclones of the autumnal season, and the active thunderstorms of heated land areas, all flourish in times and regions of strong sunshine, strong vertical temperature gradients, high humidity, and active convectional overturnings ; but temperate and higher latitudes receive practically no snowfall from them. Snowfall depends on winter storms ; these in turn would seem to depend on the general winds ; these on the increased contrast of equatorial and polar temperatures ; and this on the long aphelion winter.

In the second place, the cyclonic storms that produce snowfall in higher latitudes produce rainfall in middle latitudes. The conditions which would cause an accumulation of snowfall in northeastern America, from the cyclonic storms of winter, would also cause an accumulation of rainfall in the interior basins of Utah and Nevada. The same common process would cause an expansion of snowfields in northwestern Europe, and an extension of lakes in the arid regions of southwestern Asia.

In the third place, an increased severity of winter tempera-

tures would carry the belt of winter rains further south over the northern Sahara. This requires a little explanation. The rainfall of the northern Sahara belongs to the class known as sub-tropical rainfall. It occurs in winter, when the tropical belt of high pressure moves towards the equator, allowing the prevailing westerly winds, with their cyclones and anticyclones, to encroach on a belt of country that was six months before swept over by the parching trade winds. Now let it be remembered, that the tropical belt of high pressure owes its existence to the whirl of the general atmospheric circulation around the pole; and further, that this belt of high pressure migrates with the seasons, being pushed towards the equator in winter, when the general circumpolar winds are stronger, and relaxing towards the pole in summer, when the circumpolar winds are weaker. From this it is plain that when the contrast between winter and summer temperatures is excessive, as in the inferred conditions of the glacial period, then the migration of the tropical belt of high pressures would be increased over its present moderate measure. When it moved further towards the equator in winter than it does now, a greater area of the northern Sahara and of other similarly situated regions would be encroached upon with stormy westerly winds, and receive rainfall from the passing cyclones. While our understanding of this process comes largely from Professor William Ferrel, it is a pleasure to recognize that he had a compeer in Professor James Thomson, of Glasgow, who announced the essential explanation of the circumpolar circulation of the atmosphere over thirty years ago.

It seems, therefore, that there is an important correlation between aphelion winters, on the one hand, and heavy snowfall in glaciated regions, heavy rainfall in interior basins, and increased rainfall on the outer margin of the dry belts of the torrid zone on the other hand; the essential connection between the first and last groups of phenomena being the more rapid circumpolar whirl of the general atmospheric circulation.

I do not offer this as a panacea for all glacial troubles; but simply as a corollary following from Croll's theory, perhaps deserving the consideration of geologists and meteorologists, along with the many other factors by which the climate of the glacial period is finally to be explained.

CURRENT NOTES.

Meteorological Work in Australia.—Sir Charles Todd, K. C. M. G., F. R. S., F. R. A. S., Government Astronomer at Adelaide, South Australia, has recently prepared a paper entitled *Meteorological Work in Australia: A Review,* in which he gives a concise and interesting account of the work done in meteorology since 1860. But little had been done in meteorology before the advent of Mr. Scott, the first director of the Sydney Observatory, in 1858, who established twelve stations, each equipped with a standard barometer, dry and wet bulb thermometers, maximum and minimum thermometers, and a rain gauge. A few stations had been previously established, but the observations were not continued systematically for any great length of time.

There are now, under the direction of Mr. H. C. Russell, F. R. S., of the Sydney Observatory, in addition to that observatory, 35 meteorological stations having barometers, dry and wet bulb thermometers, maximum and minimum thermometers, and rain gauges; 139 stations with thermometers and rain gauges, and 1,063 stations with rain gauges. The Sydney Observatory is furnished with continuous self-recording barograph and thermograph, pluviometer, and anemograph; underground thermometers; evaporation tank, etc.

In Victoria there were only broken records of rainfall, temperature, and weather, made chiefly by New South Wales officials in Melbourne, from 1840 to 1849, and of rainfall up to 1851. In 1858, Prof. Neumayer, at present the director of the Deutsche Seewarte at Hamburg, began systematic observations at the new Magnetic and Meteorological Observatory at Flagstaff Hill, Melbourne. When Dr. Neumayer left, in 1863, the magnetical and meteorological divisions were transferred to the present Astronomical Observatory, and placed under the direction of Mr. R. L. J. Ellery, the astronomer who is now in charge, and under whose oversight some very valuable work has been accomplished. There are now under his direction 8 second order stations, 23 third order, and 515 rainfall stations.

In South Australia, there is a continuous record of the rainfall at Adelaide from 1839. In November, 1856, Sir Charles Todd, as government astronomer, took up the work, the observatory then coming into his charge. Under his superintendence, a system of publishing daily reports of the weather and rainfall from all stations at the head telegraph office in Adelaide was introduced, and 21 meteorological stations with barometers, thermometers, and rain gauges, as well as 370 rain-gauge stations, have been established.

In Tasmania, a magnetic and meteorological observatory was established at Hobart, and systematic observations were carried on from 1841 to 1854,

hourly readings being taken until the end of 1848. From 1855, when the Imperial Observatory was closed, the observations were carried on at Hobart until 1880 by a private observer, and in that year the Government entrusted the work to Captain Shortt, R. N., who established eight other regular stations and a number of rain-gauge stations.

In Western Australia, a meteorological observatory was established by the Government in 1876, the work being entrusted to Mr. M. A. C. Fraser, who has now 15 regular meteorological stations and 91 rain-gauge stations.

In Queensland, stations were started at Brisbane and Rockhampton by Mr. Scott, the first government astronomer of New South Wales, about 1858. In 1887, Mr. Clement L. Wragge was appointed to have charge of the work in Queensland, and at once began to establish stations all over his district. The stations are classified under five orders, according to the completeness of their equipment. The first order stations, furnished with full sets of meteorological instruments, record the various data at 3 and 9 A. M. and 3 and 9 P. M. every day (local time), and, in some cases, at the time corresponding to mean noon at Greenwich. The second order stations have generally the same equipment as those of the first order, with the usual exception of barograph and thermograph. The observing hours for these stations are 9 A. M. and 9 P. M. Third order stations are supplied with thermometer screen, hygrometer, maximum and minimum self-registering thermometers, wind compass, and rain gauge. Observations are made at 9 A. M.

Daily reports of weather and rainfall, and a synoptic map similar to that issued at Adelaide, are published for Queensland, as well as forecasts of the probable weather during the ensuing twenty-four hours. There are at present in Queensland 16 stations of the first order, 36 of the second order, 45 of the third order, and 398 rain-gauge stations. Mr. Wragge has also established stations in New Guinea, New Caledonia, Fiji, and on Norfolk Island.

In New Zealand, systematic meteorological work was begun in 1859, at first under the supervision of the Auditor-General, but in 1867 it was transferred to Dr. (now Sir James) Hector. There are 8 stations fully equipped and 79 rain stations. Sir James Hector has prepared a series of typical isobaric charts, which fairly represent all the different types of weather experienced in New Zealand. The maps are numbered in consecutive order, and copies are supplied to each station. All that is necessary, therefore, in order to have the proper weather map displayed, is for the central office to telegraph to each station the number of the map to be posted up. In the same way Mr. Russell, of Sydney, has prepared some typical pressure maps of Australia, and every day a brief description of the weather, reports from a few selected stations, and the number of the map, are exchanged between Wellington and Sydney.

Taken in all there are in Australia 357 more or less completely equipped meteorological stations, and 2,575 rain-gauge stations.

The first definite steps towards co-operation between the colonies of Australia in the matter of meteorological work were taken in 1879, when, at the

instance of Mr. Russell, a conference was held at Sydney, at which the following gentlemen were present: Mr. H. C. Russell, Government Astronomer, New South Wales; Mr. R. L. J. Ellery, Government Astronomer, Victoria; Mr. Charles Todd, Government Astronomer, South Australia; Sir James Hector, K. C. M. G., Inspector of Meteorological Stations, New Zealand. As a result of this conference plans were discussed for co-operation between all the Australian colonies in the matter of meteorological work; for a uniform mode of publication and of observation; for the establishment of first-class stations in well-selected positions; for the publication of forecasts and weather telegrams; for the establishment of meteorological observatories on high mountain peaks; for a uniform system of exposure of the instruments, etc. In 1881 a second conference, which was attended by the same gentlemen, was held in Melbourne. At this meeting it was agreed that daily isobaric maps should be issued by the head office in each colony; that a set of standard instruments (barometer, thermometer, solar thermometer, and anemometer), should be purchased for circulation between the four chief stations, viz.: Melbourne, Sydney, Wellington, and Adelaide, with a view to having the instrumental readings referred to one uniform standard. A third conference was held in Melbourne in 1888, at which all the colonies were represented, the following gentlemen attending the meeting for the first time: Mr. C. L. Wragge, Queensland; Sir John Forrest, K. C. M. G., Western Australia; Captain Shortt, Tasmania.

The daily forecasts at Adelaide are published shortly after 1 P. M., in time for insertion in the afternoon papers. These forecasts cover the twenty-four hours ending at 6 P. M. on the following day. The colonies nearly all publish daily maps, and at Adelaide, besides the isobaric map, issued since 1882, a diagram is also exhibited showing the barometric curve at selected stations along the southern coast line for the month, and recently a map showing the distribution of rain in South Australia on each wet day is also published. A monthly statement includes a comparison of the rainfall for the month with the average for the corresponding month in previous years; a discussion of the characteristics of the month in regard to pressure, temperature, cyclonic and anticyclonic areas, and weather. The annual volumes give the Adelaide observations in full, the principal data for other stations, and maps showing the amounts of rainfall by shading.

At the close of his paper the author gives a series of seven synoptic weather charts of Australia, illustrating typical weather conditions, which are fully described. A summary of Australian weather conditions is thus given. 1st. "A continual series of anticyclonic areas, which, in the winter, pass over the interior, covering the whole or greater part of the continent, with gradual falling gradients from the centre, while in the summer they pass along or near the south coast. 2d. Cyclones, disturbers of the peace, but bringing fruitful rains, — sometimes, alas! disastrous floods. These are mostly of tropical origin, and, starting on a west to southwest course, they recurve south of the trade belt, and move to the southeast. Some — those approaching from the northeast of Australia —

strike the east coast of Queensland; others enter by the Gulf of Carpentaria, and passing inland, shed rains over the western interior of Queensland and New South Wales; others pass over the interior from the northwest; whilst others again pass to the west of Australia, and ultimately rounding the Leeuwin, appear as a south coastal disturbance. 3d. Northerly extensions of the antarctic low pressure, which, passing along the south coast, give us our winter rains, and, on their retreating side, southwesterly gales."

The question of seasonal forecasts in Australia has been somewhat agitated recently, but the Australian meteorologists have not felt that they could yet take up the matter with any hope of sufficient success to justify such predictions.

Australia's position between the parallels of 11° and 39° S., gives it a tropical and a sub-tropical climate, with monsoon summer rains on the north coast and winter rains on the south coast, both extending well inland. The interior is in the anticyclonic region of high pressure and dry southeast winds, and is subject to severe droughts. The driest part is probably the belt reaching from north of the Great Bight and Lake Eyre, or about Lat. 30°, to near the northwestern coast. This is swept over nearly all the year by the southeast trade. The eastern half of the continent has a more favorable climate, for the monsoonal rains there extend further south over the coastal ranges. It would appear, from a study of past records, that when the summer is cool, with a high barometer, South Australia has a dry winter, but when the summer is hot, with a low barometer, the winter is wet.

The Australian "Southerly Burster."—In this JOURNAL for August, 1893, pages 193–194, mention was made of a prize of £25, offered by Hon. Ralph Abercromby, for the best essay on the Australian "Southerly Burster." This prize was won by Mr. Henry A. Hunt, second meteorological assistant at the Sydney Observatory, and the prize essay has been published in the Journal of the Royal Society of New South Wales, Vol. XXVIII. It embraces forty-eight pages, and is illustrated with four half-tone cuts and a number of curves and weather maps. In view of the interest in the subject, and of the fact that this is the first complete study of it, a somewhat extended summary of Mr. Hunt's essay is here given.

In the early days of the settlement of Australia, when Port Jackson was but sparsely populated, the arrival of the "Southerly Burster" was always heralded by a cloud of reddish dust, gathered on its passage over a considerable extent of brick fields, and in consequence of this phenomenon it gained the local name of "brickfielder." These brickfields have disappeared since the early colonization days, as well as the name "brickfielder," and now the name given to the phenomenon is "Southerly Burster." It appears from a study of the earliest reliable records that the name and the characteristics of the old "brickfielder" have changed in modern times. In former times the velocity of the wind was often sixty miles an hour, and on one occasion it reached the tremendous velocity of one hundred and fifty-three miles. At present, the velocity is seldom over fifty miles, and is usually between twenty and forty miles. The cause of this change may be the

increased friction and obstruction resulting from the modern buildings or the decreased absorption or radiation of heat from the cultivated soil, which has now taken the place of the former hard, unbroken surface.

The " burster " is preceded by a period of high temperature, varying from three hours to three or more days, accompanied in the early part of the summer or towards its close by wind from the west or northwest, and in the midsummer months, generally from the northeast. The sky is white and hazy on the early morning of the day on which the " burster " occurs, and as the hour of the outbreak approaches, ball-shaped cirro-cumulus clouds appear in the south, and frequently, if thunder and lightning are to accompany the squall, heavy cumulus thunder-clouds are also seen rising in the southwest. The cloud phenomena more immediately preceding the " burster ' are a heavy cumulus roll low down on the southern horizon, or sometimes in the south-southwest or southwest. This roll is sharply defined, being dark on the edges with lighter shades towards the centre; is from thirty to sixty miles long; sometimes appears singly, while on other occasions many such formations are heaped up one above another, with light cirrus below. If the burst is of the first order it is followed by an overcast sky composed of nimbus, from which patchy rain descends. The symmetrical appearance of the cloud roll is gradually lost as it approaches and a light cirrus fringe may be seen rising from underneath in front, falling over the top, and trailing behind the advancing cloud.

Just before the " burster " arrives, the northerly wind which has been blowing with increasing force suddenly ceases and a calm prevails, broken at intervals by fitful puffs. This calm lasts longer if the " burster " comes at night than if it comes by day. The cloud roll then approaches rapidly, preceded by clouds of dust; light clouds rush forward from under the roll and are thrown back over the top of it as they reach the front, and in a few moments a gale is blowing. A " burster " rarely brings immediate rain, except when accompanied by a thunderstorm, the hot, dry conditions prevailing on the plains before the " burster " being conducive to dryness.

" Southerly bursters " have been observed to result from three types of cyclonic areas. The first is the familiar Λ depression, which gives the true " southerly burster," the one usually experienced. As a rule, the sharper the Λ the more sudden is the change. The second type is the tropical depression or tongue which may be looked upon as an inverted Λ. This occurs only in the monsoonal season, and even then rarely. It is accompanied by an overcast tropical sky, which almost invariably is found preceding the southerly current. " Bursters " occurring under these conditions have a high temperature, are not, generally speaking, very strong. Thunderstorms are prevalent. The third condition of occurrence results from a secondary. " Bursters " of this type are rare. They develop through the formation of a " kink " in the outlying isobars of a retreating high pressure.

As a whole the " burster " is unfavorable to rainfall. It may bring a few showers to the coastal areas, but it serves as an indication that the country west of the ranges is, at least temporarily, in a dry condition. In spite of this fact, the frequent recurrence of " bursters " is desirable, for their non-

occurrence, or infrequency, denotes a failure of activity in the cyclonic and anticyclonic systems, or, in the early part of the year, a failure of the monsoonal rains. "Bursters" are less frequent and less violent than usual in seasons of drought and in seasons of deluge. They are uncertain in their duration and in their periods of occurrence. The shortest one on record extended over a period of three hours; the longest covered a space of ten days. Two have often occurred within twenty-four hours, and sometimes a month elapses between two successive occurrences. The northern limit of the "burster" is defined by the southeast trades, about latitude 30° S. "Bursters" always result in a diurnal fall in temperature, which ranges between 37.5° and 4.2°, the average fall being 18.1°. The greatest diminution of temperature takes place during the first hour, and the fall is most sudden when the burst comes at midday. The maximum wind velocity is usually reached about twelve hours after the commencement of the burst.

Mr. Hunt has prepared a table of all the "bursters" that have been recorded at Sydney from Sept. 30, 1863, to March 31, 1894, from which it appears that the largest number in any one year was 56 in 1869, the smallest, 16 in 1890. Since 1888, there has been a falling off in the number, and this is coincident with abundance of rain each year. "Bursters" are most frequent from 6 P. M. to midnight, and least frequent from 11 A. M. to 1 P. M. The average of the greatest velocities of wind is 42.7 miles per hour. The mean velocity of the wind is greater in spring than in autumn. An examination of barometric curves shows that "bursters" occur some hours after the barometer has begun to rise; also that no particular height of barometer is peculiar to the "burster."

Annual Report of the Meteorological Department of India. — The *Report on the Administration of the Meteorological Department of the Government of India in* 1893-94 is divided into two parts, the first of which gives the general account of the results of the more important sections of the work of the Department, and the second, the usual details of administration, chiefly in the form of tables.

During the year April 1, 1893, to March 31, 1894, there have been established three new stations of the third class, making 177 stations in all, 174 of which are under the immediate control of the Meteorological Department. Two observatories have been established, at Teheran and Ispahan, which have already yielded valuable data regarding the cold weather storms of Northern India, and observations have been taken at Port Victoria, on the Seychelles Islands, near the equator in the Arabian Sea, with a view to determining the value of these islands as an observing station in co-operation with the land stations. The observations made at Trivandrum from 1853 to 1864 have been prepared for publication, and a portion of the first volume, containing the pressure records, is ready for issue. The snowfall data collected during the winter from the Himalayan and Afghan mountain areas were more complete than those obtained in any previous winter. From the data furnished by officials in the Chamba and Simla divisions it appears that the amount of snowfall on the higher elevations in the Western Himalayas, above 12,000 to 15,000 feet, is at least 40 feet in favorable years, and may reach 60 to 80 feet in years of excessive snowfall.

The number of stations inspected was 53, a smaller number than in the previous year. Of the 53, 7 were found "very satisfactory"; 22 "satisfactory"; 16 "fair," and 8 "bad." Arrangements have been made to provide for the systematic instruction of observers by certain of the officers of the first-class observatories. One hundred new rain-gauge stations were established during the year. The number of sets of storm observations increased from 368 in 1892–93 to 530 in 1893–94. The work of the division of marine meteorology has been more extended than in previous years, the number of barometric comparisons made reaching 7,744. Daily weather charts of the whole Indian monsoon area have been regularly issued since May 10, 1893. The seasonal forecast of the probable character of the rainfall during the southwest monsoon was well verified.

The storm-warning service is performed by the Calcutta office for the Bay of Bengal and by the Simla office for the Arabian Sea, and ample and early warning was given of all the more important storms which visited the Indian coasts in 1893–94. A very good proof that this service was well performed is found in the fact that no criticism or suggestions of improvement were received from anyone interested in it. The flood warnings, also, were very satisfactory. Regarding meteorological observations taken in certain forests, Mr. Eliot, the writer of the present Report, says: "It appears to me very doubtful whether it is desirable to continue these observations. Experience, as well as theory, appear to indicate that any differences with regard to temperature, humidity, etc., due to forest growth, will very probably be small in amount, and their determination requires not only careful and accurate, but also intelligent, observation, in order that these effects may be ascertained without intermixture with other unknown effects."

Daily weather reports and charts are issued at Calcutta, Madras, and Bombay. The publications issued during the year have been noticed in this JOURNAL. The following publications will shortly be issued: —

(1) Part IV. of Volume V. of the Indian Meteorological Memoirs containing a discussion of the hourly observations taken at Allahabad and Lucknow.

(2) Instructions to observers of the India Meteorological Department.

(3) Hourly meteorological observations at Trivandrum during the years 1853 to 1864.

Popular Ideas as to the Effect of Cultivation on Rainfall. — It is interesting to note a curious swing of popular opinion in the West regarding the effect of cultivation of the soil and other results of advancing civilization on the amount of precipitation. Some few years ago there was a very general belief in the West that the advance of settlements, the cultivation of the plains, and the planting of trees had materially increased the rainfall over that region. Indeed, many persons went so far as to think that the building of railroads and of telegraph lines had a marked effect on the precipitation. During the past summer, however, when several of our Western States suffered severely from drought, there has been a sudden swing of

opinion to the opposite view, viz.: that the draining of bogs and the cultivation of the soil has tended to decrease the rainfall. A correspondent of the Des Moines (Iowa) *Register* upholds the latter theory as follows: "A careful study of this problem leads unmistakably to the conclusion that the work of man in this country for the last hundred years has tended to diminish the amount of vapor in the atmosphere, and at the same time increase the temperature. . . . Throughout the great central plain, thousands of lakes, ponds, sloughs, and marshes have been drained every year, and just so much evaporating surface has been destroyed. The cultivation of the soil, by allowing the water to enter it freely, has prevented the water collecting where it would be exposed directly to the sun's rays. . . . In these extreme western sections the droughts have been made severe in a marked degree because, by allowing the water to enter the soil, it is not evaporated so freely and is distributed over a longer period of time, whereas if the water could be turned into vapor in a short time, it would often save the growing vegetation from destruction."

In connection with this very modern aspect of the theory of the effect of cultivation on rainfall, Mr. J. R. Sage, Director of the Iowa Weather and Crop Service, has a paper in the November, 1894, number of the Bulletin of that Service, entitled "The Drought Problem," which was read before the Iowa Dairy Convention at Ames, Iowa, Nov. 15, 1894. Mr. Sage says that the dry summer of 1894 is not a sign that the climate is changing, and further adds: "It is not true that cultivation of soil decreases evaporation. In fact, it can be demonstrated that breaking up the hard and well-nigh impervious prairie sod, turning under the dry and wiry wild grasses, stirring the soil deeply, making it both receptive and retentive of moisture and ready to yield it up for the sustenance of plants, thereby producing heavy crops in place of the scanty native herbage of the plains, serve to increase rather than decrease evaporation and humidity. The original upland prairie was hard at the surface, and measurably impervious, and the heavy rains were carried quickly into the depressions, making their way thence into the larger streams. As the result of breaking and sub-soil ploughing the receptive fields absorb a much greater share of the heavy rains than formerly, and the moisture is held therein, and by capillary attraction is made available for growing plants." The author says further that there is more vapor arising from a dense grove than from an equal extent of water surface, and that a tile-drained and well-cultivated field will resist aridity better, and will contribute more vapor to the air, than the same soil in its original condition.

Weather Bureau Notes. — The interest manifested by every class of people in the subject of climate and its influence on health and disease has determined the Honorable the Secretary of Agriculture, through the medium of the Weather Bureau, to undertake the systematic investigation of the subject.

It is hoped to make the proposed investigation of interest and value to all, but especially to the medical and sanitary professions, and to the large

number of persons who seek, by visitation of health resorts and change of climate, either to restore health or prolong lives incurably affected or to ward off threatened disease.

The study of the climates of the country in connection with the indigenous diseases should be of material service to every community, in showing to what degree local climatic peculiarities may favor or combat the development of the different diseases, and by suggesting, in many instances, supplementary sanitary precautions; also by indicating to what parts of the country invalids and health seekers may be sent to find climatic surroundings best adapted to the alleviation or cure of their particular cases.

The hearty co-operation of the various boards of health, public sanitary authorities, sanitary associations and societies, and of physicians who may feel an interest in the work, is asked to achieve and perfect the aims of this investigation.

No compensation can be offered for this co-operation other than to send, free of cost, the publications of the bureau bearing upon climatology and its relation to health and disease to all those who assist in the work.

Co-operation will consist in sending to this office reports of vital statistics from the various localities. That these reports may be of value, it is evident to all that they should be accurate and complete, and be rendered promptly and regularly. Blank forms of reports have been prepared so as to occasion as little trouble and labor as possible on the part of the reporter, and will be furnished by the Bureau on application.

At the very beginning of the investigation it is not possible to outline precisely the channels through which the results obtained will be made public, but it is hoped to publish soon a periodical devoted to climatology and its relations to health and disease. The publication will probably resemble in size and general appearance the present *Monthly Weather Review*, the subject matter being, of course, different.

More detailed information will be furnished on application.

Annual Summary of the New England Weather Service.—The annual report of Mr. J. Warren Smith, Director of the New England Weather Service, in regard to the work of that Service in 1893, appears in Volume XLI., No. II., of the *Annals of the Astronomical Observatory of Harvard College*. During the year there has been an increase of eight new stations, making in all 199, besides 12 regular Weather Bureau stations, which report to the Central Office. The temperature of the year was 1.4° below the normal, and the precipitation shows a deficiency of 0.29 in. The Report contains, as usual, a general summary of the meteorological conditions during the year; a classification of the cyclones which affected the weather of New England; the dates of occurrence of the most severe cyclones and local storms, with a short description of the damage done in each case, and tables containing the usual data.

It is a pleasure to quote Mr. Smith's words in commendation of his observers: "When the early date on which our monthly bulletins are issued, as a rule, is considered, it will be seen that the voluntary observers

of this Service can hardly be excelled in promptness and regularity. There are a few, who, from carelessness or other causes will nearly always send in a late report, and there are generally one or more each month who are unable to make observations at all; but on the whole, we have only words of praise to give. The blanks are nearly always neatly filled also, and the computations very accurate, showing a high appreciation of the work."

The Roumanian Weather Service in 1892. — Volume VIII. of the Annals of the Meteorological Institute of Roumania contains the Annual Report of the Director, Dr. Stefan C. Hepites, for the year 1892, together with the usual meteorological data, the hourly observations at Bucharest, and the observations made at Pancesti-Dragomiresti during 1886–1890. The Memoirs in this volume are as follows: "*La Pluie en Roumanie en* 1892"; "*Registre des Tremblements de Terre en Roumanie en* 1892"; "*Organisation du Service Météorologique en France*"; "*Le Pluviomètre de l'Institut Météorologique de Roumanie.*"

The year 1893 witnessed an additional grant of money to pay for the establishment of new stations and the building of a new central station for the Institute. The Bulletin has been changed somewhat, owing to the increase in the number of stations, and now gives each month the summary for 20 stations of the second order, and the rainfall for 200 stations. At the end of the year 1893 there were 159 stations, including 1 of the first order; 23 of the second; 2 of the third, and 133 of the fourth. It has been decided to build a mountain observatory on Mount Furnica, in Prahova, at a height somewhat over 1,500 meters. Vols. VI. and VII. of the Annals were published during the year 1892, and it is hoped that these publications will be issued more promptly in the future.

The three memoirs on Rainfall, Earthquakes, and the Pluviometer are in French as well as Roumanian; that on the Meteorological Service in France is in Roumanian only. The volume contains two views of the Meteorological Institute building in Bucharest.

Royal Meteorological Society. — The annual meeting of this society was held on Wednesday evening, Jan. 16, at the Institution of Civil Engineers, Great George Street, S. W.; Mr. R. Inwards, F. R. A. S., President, in the chair.

The Council, in their Report, reviewed the work done by the society during the past year, and also stated that additional accommodation had been provided to meet the growing needs of the library. Forty-five new Fellows had been elected during the year.

Mr. Inwards, in his presidential address, dealt with the subject of "Weather Fallacies," which he treated under the heads of Saints' Day fallacies, sun and moon fallacies, and those concerning animals and plants. He also referred to the almanac makers, weather prophets, and impostors, who have from time to time furnished the world with fit materials for its credence or its ridicule.

Mr. C. Harding read a paper on "The Gale of Dec. 21, and 22, 1894,

over the British Isles." This storm was one of exceptional severity, especially over the northern portions of England and Ireland, and in the south of Scotland. It developed energy very quickly and travelled with great rapidity. The self-recording anemometers show that the greatest violence of the wind occurred at Fleetwood, where the velocity was 107 miles in the hour between 8.30 and 9.30 A. M. on the 22d; and for four consecutive hours the velocity exceeded 100 miles. This is the greatest force of wind ever recorded in the British Isles, and is 10 miles an hour in excess of the highest wind velocity in the great storm of Nov. 16–20, 1893. At Holyhead the wind in squalls attained the hourly velocity of 150 miles between 10 A. M. and noon, on the 22d. The strongest force was mostly from the northwestward. Much destruction was wrought both on sea and land, and there was a heavy loss of life.

New England Meteorological Society. — The thirty-second regular meeting of the New England Meteorological Society was held on Jan. 19, 1895, at the Massachusetts Institute of Technology, Boston, Mass. Messrs. George C. Whipple and Henry E. Warren read a paper on the Thermo phone, a new instrument designed to determine the temperature at distant and inaccessible points. Curves were shown illustrating the fluctuations of temperature in the water of Lake Cochituate at different depths, as recorded by the thermophone, and the members present were given an opportunity to test the instrument themselves.

Prof. W. M. Davis spoke briefly on the "Elementary Divisions of the Zones." Prof. Davis remarked that in the ordinary divisions of the zones too much emphasis was given to the similarity of the two temperate zones, whose climates were, in reality, very unlike. He proposed, therefore, to describe first the South Temperate Zone, mostly oceanic, in which the temperature is prevailingly moderate, cool, and uniform, while in the northern hemisphere these features appear only on the oceans, and the lands are characterized by extreme changes of the seasons, and hence should in the earliest teaching be at once introduced as the types of extreme seasonal change, having cool or cold winters and hot or warm summers.

Continental extremes fail, however, to reach the western side of the continents where the moderating influences of the westerly winds from the oceans reduce the seasonal range; while on the other hand they are extended from the eastern side of the lands to the bordering oceans, for here the warm westerly winds of summer and the cold westerly winds of winter carry strong seasonal changes from the lands out for a certain distance over the sea.

While the boundaries of the zones are somewhat irregular, yet the irregularities are so systematic that they can be easily remembered. The torrid zone widens somewhat on the lands, because the torrid oceans are held at a somewhat moderate temperature by a circulation of their waters over great ranges of latitude in the same way the north frigid zone extends farthest from the pole on the lands, because the oceans have their extreme cold, somewhat moderated by the oceanic circulation. The strongly changing

seasons of the northern continents are represented only in a small way on the lands of the southern hemisphere.

Mr. A. L. Rotch exhibited a number of barograph records taken by a portable barograph that he has carried on his travels during recent years. The range of latitude covered extends from North Cape, Norway, +71°, to the Straits of Magellan near the extremity of South America, —54°. An interesting feature of the barograph curves is a distinct exhibition of strong cyclonic range of pressure in far northern and southern latitudes, while these are replaced by the regular double diurnal oscillations, plainly perceptible in the torrid zone. While on the open sea the two oscillations are about equal, but on approaching the coast the minimum is seen to strengthen.

Mr. R. DeC. Ward exhibited a number of recent publications. Among these were a chart of the distribution of thunderstorms over the world, sent to the Society by Prof. Klossovsky, of Odessa, Russia; a recent atlas of charts of rain-fall and snow for the United States, prepared by Prof. M. W. Harrington, Chief of the Weather Bureau; and a series of elaborate monthly charts of the pressure of the North Atlantic, issued by the Danish Meteorological Office at Copenhagen, under the direction of Capt. C. Rung.

Prof. Davis reported for the committee appointed Jan. 27, 1894 (Messrs. Davis, Upton, and Ward), to consider instruction to teachers on the use of weather maps in schools, that a series of ten meetings is in progress with about twenty teachers from the grammar schools of Cambridge, in charge of himself and Mr. Ward. Mr. Ward is conducting a similar course with the teachers at Hingham, Mass., and is in correspondence with school superintendents elsewhere on the subject.

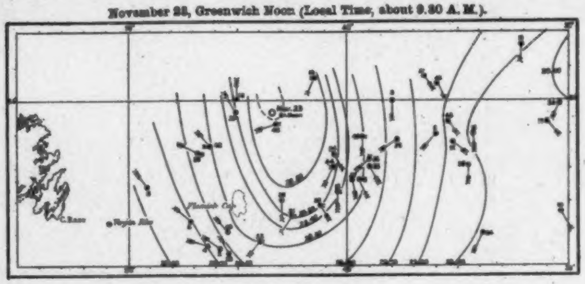
*Eight Synoptic Charts showing a Compound Curve in a Storm Track.** — The eight small synoptic charts shown (on the accompanying sheet) illustrate a storm which developed rapidly to maximum energy which was maintained for about thirty hours, after which the storm disappeared as rapidly as it came. It will be seen from the positions plotted that the track of the storm centre from Greenwich noon, Nov. 23, to Greenwich noon, Nov. 24, was an abnormal one, in the nature of a compound curve, and sufficiently erratic to baffle the master endeavoring to con his vessel clear of the storm centre. It is, perhaps, too much to expect of a single observer acting independently to foresee an unusual movement of the centre and to be prepared for such. But if he cannot tell what is going to happen, he can, commonly, by careful and constant observation of his instruments, the clouds, wind, and sea, form a correct idea of the storm's general action as the changes occur from hour to hour. In the case of the storm under consideration, Capt. Leitch, Br. S. S. "Potomac," on his arrival in port forwarded to this Office a complete set of observations and a draft of the storm track as plotted by him during the storm. This track coincides almost exactly with the one here shown and illustrates how a careful navigator, although isolated from all other observers, can determine for himself the true state of affairs.

* From the March, 1895, Pilot Chart of the North Atlantic Ocean.

THE STORM OF NOVEMBER 23 AND 24, 1894.

EIGHT SYNOPTIC CHARTS, SHOWING A COMPOUND CURVE IN A STORM TRACK.

November 23, Greenwich Noon (Local Time, about 9.30 A. M.).



No.	Vessel.	No.	Vessel.	No.	Vessel.
2	Amalia, Br. ss.	19	Fortunata, Br. ss.	39	Nessmore, Br. ss.
3	Angloman, Br. ss.	20	Gut Heil, Ger. ss.	40	Palestine, Br. ss.
4	August Korff, Ger. ss.	21	Hurona, Br. ss.	41	Palmyra, Ger. ss.
5	[illegible] Standard, Br. ss.	24	Knight of St. George, Br. ss.	42	Pomeranian, Br. ss.
6	Bohemia, Ger. ss.	28	Lancastrian, Br. ss.	45	Potomac, Br. ss.
8	Buenos Ayrean, Br. ss.	29	Laurentian, Br. ss.	46	Roman, Br. ss.
10	Cape Roca, Br. ss.	31	Lord Charlemont, Br. ss.	48	Rosita, Br. ss.
11	Chester, Dutch ss.	32	Lucerne, Br. ss.	50	St. Giles, Br. ss.
12	Chester, Br. ss.	33	Manhattan, Br. ss.	52	Standard, Ger. ss.
13	Circassia, Br. ss.	34	Maryland, Br. ss.	54	Templemore, Br. ss.
15	Elise Maria, Ger. ss.	35	Michigan, Br. ss.	55	Virginian, Br. ss.
17	Europe, Br. ss.	36	Mississippi, Br. ss.	60	[illegible], Ger. ss.
18	Excelsior, Br. ss.	37	Mobile, Br. ss.		

CHART SYMBOLS.

○ Calm. * Snow. : Rain.

NW., force 12. △ Hail. ⊕ Overcast.

○—stiller, force 6. ⊖ No report of clouds.

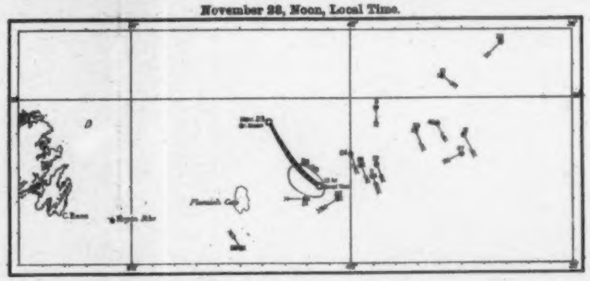
WEATHER SYMBOLS.

C.—Cloudy weather.
D.—Drizzling, or light rain.
G.—Gloomy, or dark stormy looking weather.
H.—Hail.
M.—Misty weather.
O.—Overcast.
Q.—Squally weather.
R.—Rainy weather, or continuous rain.
S.—Snow, snowy weather, or snow falling.
U.—Ugly appearance or threatening weather.

SEA SYMBOLS.

B.—Broken or irregular sea.
C.—Chopping, short, or cross sea.
H.—Heavy sea.
L.—Long rolling sea.
M.—Moderate sea or swell.
R.—Rough sea.

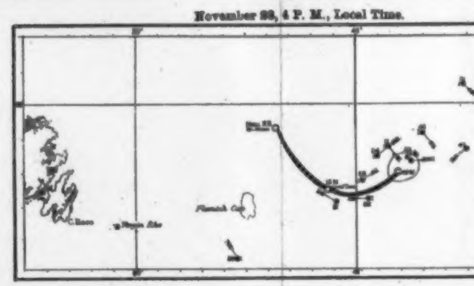
November 23, Noon, Local Time.



Reports; November 23, Noon, Local Time.

No.	Vessel.	Barometer corrected.	Sea— From:	Sea— State of:	Weather.	Remarks.
3	Angloman, Br. ss.	29.40	SW.	M.	G.	Strong winds; dark, gloomy weather; occasional rain squalls; barometer falling rapidly.
11	Chester Dutch ss.	29.38	SSE.	H.R.	O.Q.R.	Very high and rough sea.
12	Chester, Br. ss.	29.75	SE.	M.	O.U.	Increasing wind and sea, squally.
21	Hurona, Br. ss.	29.41	SSE.	R.	O.R.G.	Wind backing; rain squalls; NW'ly swell [illegible].
23	Kansas City, Br. ss.	29.40	S.	R.	O.	Dull sky all day; rain squalls at night.
31	Lord Charlemont, Br. ss.	29.01	NW.	H.	G.	Wind backing.
33	Lucerne, Br. ss.	29.35	WSW.	H.	R.	Strong wind, backing; thick rain; high cross sea.
37	Mobile, Br. ss.	29.40	SE.	R.	O.M.	Wind backing and freshening; barometer falling rapidly.
45	Potomac, Br. ss.	29.39	SSW.	R.	C.	Moderate gale, backing to SE. and increasing; sea rising rapidly.
47	Rialto, Br. ss.	29.74			Q.	
50	Sarmatian, Br. ss.	29.75	WSW.	R.	O.D.	
52	Standard, Ger. ss.	29.20	NW.	H.	U.R.	Calm. At 10.30 A. M. wind went to WNW. and blew a fresh gale for a short time; sea rising quickly; squally weather; clouds (Ni) from SW., traveling fast.
54	Templemore, Br. ss.	?	SSE.	H.	G.	Wind increasing and backing toward SE.
55	Virginian, Br. ss.	29.35	SSE.	R.	Q.R.	Heavy, thick, blinding rain and rising sea.

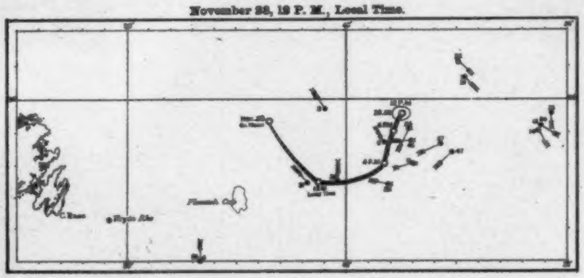
November 23, 4 P. M., Local Time.



Reports; November 23, 4 P. M., Local Time.

No.	Vessel.	Barometer corrected.	Sea— From:	Sea— State of:	Weather.	Remarks.
11	Chester, Dutch ss.	29.40	SSE.	H.R.R.	O.R.Q.	Sea, high, rough and very irregular.
12	Chester, Br. ss.	29.45	SE.	H.	O.U.Q.R.	Dark, heavy loaded sky; wind and sea increas[illegible]
21	Hurona, Br. ss.	29.40	SE.	R.H.	O.R.Q.	At 3.30 wind increased to a whole gale; force [illegible] gradually increasing heavy; slight NW. swel[illegible] to hail; barometer falling steadily.
31	Lord Charlemont, Br. ss.	28.69	NW.	H.	G.	Strong gale with rain and heavy sea, increasing [illegible]
33	Lucerne, Br. ss.	29.09	W.	H.	R.	Strong gale, high sea and continuous heavy rai[illegible]
37	Mobile, Br. ss.	29.35	SE.	H.	U.	
45	Potomac, Br. ss.	29.31	SSE.	U.	O.Q.U.R.	Wind backing, freshening fast; barometer falli[illegible]
47	Rialto, Br. ss.				Q.	
50	Sarmatian, Br. ss.	29.61	WSW.	H.	O.D.	
52	Standard, Ger. ss.	29.40	NW.	H.	O.D.	Strong gale, high sea, rain and hail squalls. Wi[illegible] ing; thunder; clouds (N) from SW., fast. Hail at times.
54	Templemore, Br. ss.	?				
55	Virginian, Br. ss.	29.07	Continued.		H.	At 2 P. M. wind east, strong, backing to NE.; w[illegible]

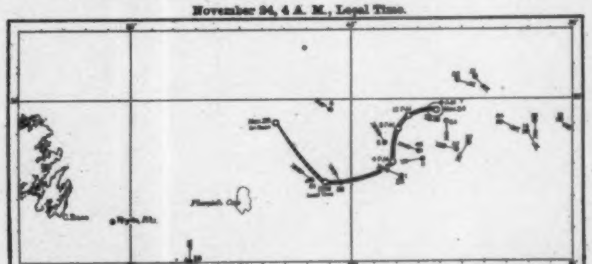
November 23, 12 P. M., Local Time.



Reports; November 23, 12 P. M., Local Time.

No.	Vessel.	Barometer corrected.	Sea— From:	Sea— State of:	Weather.	Remarks.
3	Angloman, Br. ss.	29.20	NNW.	H.	U.	Still blowing a hurricane; barometer rising rapidly. Mountainous sea.
6	Bohemia, Ger. ss.	29.60	NNW.	L.R.	O.	
11	Chester, Dutch ss.	28.96	SE. and W.	H.R.R.	O.R.Q.	Heavy rain all the watch; sea increasing.
12	Chester, Br. ss.	29.45	SE.	H.	O.Q.	Weather same as at 8.
14	Colorado, Br. ss.	29.72	SSW.	H.	Q.	Black clouds from the south; barometer falling; wind and sea increasing.
21	Hurona, Br. ss.	28.90	SE.	H.	O.R.Q.	Sky clearing overhead; wind decreased to force 10; very heavy sea running.
30	La Bretagne, Dutch ss.	29.45	S.W. by S. and NW.	H.R.	Q.C.	Strong gale; high confused sea.
31	Lord Charlemont, Br. ss.	28.90	NW. by N.	H.	G.	Storm with terrible squalls of hail; mountainous sea.
33	Lucerne, Br. ss.	29.10	WNW.	H.	R.	Weather same as at 8.
34	Maryland, Br. ss.	29.10	SE.	H.	O.Q.R.	
37	Mobile, Br. ss.	29.10	S.	R.H.	O.	
45	Potomac, Br. ss.	28.87	WSW.	H.	O.Q.U.R.	Hurricane with terrible squalls; mountainous sea; ship enveloped in flying foam.
47	Rialto, Br. ss.		SW.	H.	G.	
50	Sarmatian, Br. ss.	29.56	S.	H.	O.	
52	Standard, Ger. ss.	29.01	NNW.	H.	O.H.	Strong gale; high sea; very heavy hail squalls. At 10 P. M. wind and sea decreasing a little; lightning in the SW.
54	Templemore, Br. ss.	?				At 9.30 wind came out from SW., force 6; barometer began to rise.
55	Virginian, Br. ss.	28.42	N.	H.	Q.	At 9 P. M. wind and sea were so furious could not keep ship bow to.

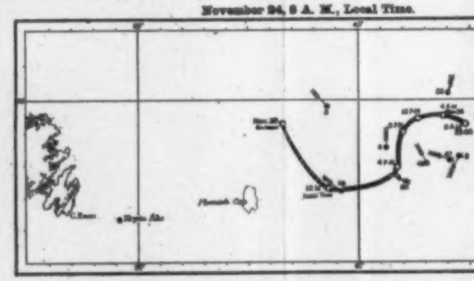
November 24, 4 A. M., Local Time.



Reports; November 24, 4 A. M., Local Time.

No.	Vessel.	Barometer corrected.	Sea— From:	Sea— State of:	Weather.	Remarks.
3	Angloman, Br. ss.	29.45	NW.	R.	C.	Weather moderating slightly; sea going down; wind hauling more to W'd.
6	Bohemia, Ger. ss.	29.59	NNW.	L.R.	O.	
11	Chester, Dutch ss.	29.01	W.	H.R.R.	O.R.Q.	Constant rain with very heavy squalls; long, high westerly sea.
12	Chester, Br. ss.	29.41	SE.	H.	O.R.Q.	Weather same as at 12.
14	Colorado, Br. ss.	29.39	SSW.	H.	Q.	Still blowing moderate gale with strong gusts at intervals.
21	Hurona, Br. ss.	28.99	SE., S. and SW.	H.C.	R.C.Q.	At 1 A. M. wind decreased to strong SE. gale with very heavy squalls; confused sea from SE., S. and SW., causing vessel to labor heavily; barometer steady, squally, wind decreasing to fresh breeze.
30	La Bretagne, Dutch ss.		SSE.–SW.	H.R.B.	Q.P.	
31	Lord Charlemont, Br. ss.	28.99	NW. by N.	H.	G.	Fierce gale with terrible hail squalls moderating slightly; sea very heavy.
33	Lucerne, Br. ss.	29.17	WNW.	H.	R.	Whole gale with terrible rain; fearful sea.
34	Maryland, Br. ss.	29.07	SE.	H.	O.Q.R.	
37	Mobile, Br. ss.	29.15	S.	R.H.	O.	
45	Potomac, Br. ss.	28.91	W.	H.	O.O.U.	
47	Rialto, Br. ss.		W. by S.	H.	O.	
50	Sarmatian, Br. ss.	29.56	S.	H.	Q.	At 3 A. M. wind SE. by E. 5.
52	Standard, Ger. ss.	29.22	NNW.	R.	H.	Wind and sea decreasing; strong hail squalls.
54	Templemore, Br. ss.	?				Barometer rising.
55	Virginian, Br. ss.	28.87	NNW.	H.	Q.	Weather improving slowly.

November 24, 8 A. M., Local Time.



Reports; November 24, 8 A. M., Local Time.

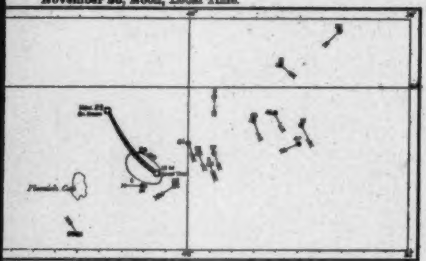
No.	Vessel.	Barometer corrected.	Sea— From:	Sea— State of:	Weather.	Remarks.
3	Angloman, Br. ss.	29.60	NW.	R.	C.	Weather moderating fast; high sea on [illegible]
6	Bohemia, Ger. ss.		NNW.	L.R.	O.	
11	Chester, Dutch ss.	29.21	SW.	H.R.L.	O.U.R.Q.	Since 4 A. M. wind increasing and hauling south[illegible]
21	Hurona, Br. ss.	29.10	SE. & SW.	H.C.	R.C.	Barometer rising slowly from 4 A. M.; weather [illegible] moderated sea from SE., E., and SW.; wind [illegible] terrific gale with tremendous sea; ship [illegible] vessel. Had two boats smashed in davits and [illegible]
33	Lucerne, Br. ss.	29.29	NW.	H.	C.	
34	Maryland, Br. ss.	29.11	SW.	H.	O.Q.R.	
37	Mobile, Br. ss.	29.25	S.	R.H.	O.	
45	Potomac, Br. ss.	29.06	NNW.	H.	O.O.U.	
47	Rialto, Br. ss.		NW.	H.	C.	
50	Sarmatian, Br. ss.	29.12	S.	H.C.	R.R.	At 6 A. M. the wind was E. by N., force 4; at 8 A. M. [illegible] N. [illegible] increased to force 10 at 8 A. M.
55	Virginian, Br. ss.	29.09	NNW.	H.	G.	Weather slowly improving.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

THE STORM OF NOVEMBER 23 AND 24, 1894.

EIGHT SYNOPTIC CHARTS, SHOWING A COMPOUND CURVE IN A STORM TRACK.

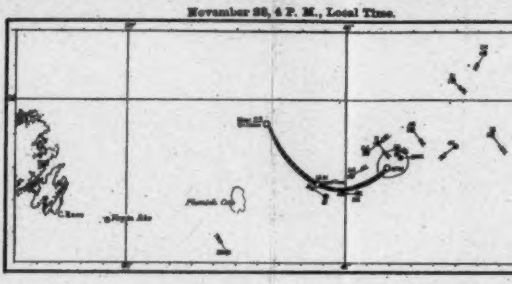
November 23, Noon, Local Time.



Reports; November 23, Noon, Local Time.

Sea— From:	Sea— State of:	Weather.	Remarks.
SW.	M.	C.	Strong winds; dark, gloomy weather, occasional rain squalls; barometer falling rapidly.
SSE.	H. R.	O. Q. R	Very high and rough sea.
SE.	M.	O. U.	Increasing wind and sea, squally.
SSE.	R.	O. R. Q.	Wind backing; rain squalls; NW'ly swell still felt.
S.	R.	O.	Dull sky all day; rain squalls at night.
NW.	H.	Q.	Wind backing.
WSW.	H.	R.	Strong wind, backing; thick rain; high cross sea.
SE.	R.	O. M.	Wind backing and freshening; barometer falling rapidly.
SSW.	R.	C.	Moderate gale, backing to SE. and increasing; sea rising rapidly.
		Q.	
WSW.	R.	O. D.	
NW.	H.	U. R.	Calm. At 10.30 A. M. wind went to WNW. and blew a fresh gale for a short time; sea rising quickly; squally weather; clouds (Ci) from NW., traveling fast.
SSE.	H.	O.	Wind increasing and backing toward SE.
SSE.	R.	O. R.	Heavy, thick, blinding rain and rising sea.

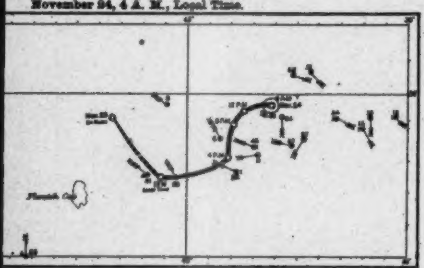
November 23, 4 P. M., Local Time.



Reports; November 23, 4 P. M., Local Time.

No.	Vessel.	Barometer.	Sea— From:	Sea— State of:	Weather.	Remarks.
11	Chester, Dutch ss.	[illegible]	SSE.	H. R. R.	O. R. Q.	Sea high, rough and very irregular.
19	[illegible], Br. ss.	[illegible]	SW.	R.	O. U. Q. R.	Dark, heavy loaded sky; wind and sea increasing.
21	[illegible], Br. ss.	[illegible]	SE.	R. H.	O. R. Q	At 3.30 wind increased to a whole gale; heavy squalls of [illegible] gradually becoming heavy; slight NW. swell, but a SSW. [illegible] to fair; barometer falling steadily.
[illegible]	Lord Charlemont, Br. ss.	[illegible]	NW.	H.	Q.	Strong gale with rain and heavy sea, increasing.
[illegible]	Lucerne, Br. ss.	[illegible]	W.	R.	R.	Strong gale, high sea and continuous heavy rain.
[illegible]	Mobile, Br. ss.	[illegible]	SE.	H.	U.	Wind backing, freshening fast; barometer falling fast.
46	Potomac, Br. ss.	[illegible]	SSE.	H.	O. Q. [illegible] R.	
47	[illegible], Br. ss.				Q.	
[illegible]	Sarmatian, Br. ss.	[illegible]	WSW.	R.	O. R.	
[illegible]	Standard, Ger. ss.	[illegible]	NW.	H.	O. R.	Strong gale, high sea, rain and hail squalls, wind going to [illegible] ing weather; clouds (Ci) from NW., fast.
54	Templemore, Br. ss.	?				[illegible]
[illegible]	Virginian, Br. ss.	[illegible]		Confused.	R.	At 3 P. M. wind east, strong, backing to NE.; weather thick [illegible]

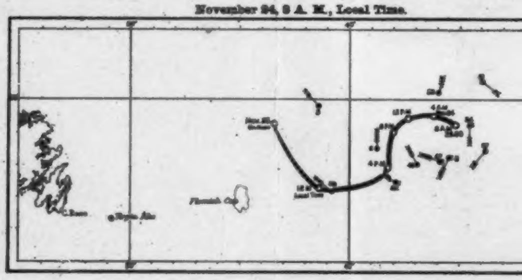
November 24, 4 A. M., Local Time.



Reports; November 24, 4 A. M., Local Time.

Sea— From:	Sea— State of:	Weather.	Remarks.
SW.	R.	C.	Weather moderating slightly; sea going down; wind backing more to W'd.
NNW.	L. R.	O.	
W.	H. R. R.	O. R. Q.	Constant rain with very heavy squalls; long, high westerly sea.
SE.	H.	O. R. Q.	Weather same as at [illegible].
SSW.	H.	Q.	Still blowing moderate gale with strong gusts at intervals.
SE., S. and SW.	R. C.	R. C. Q.	At 1 A. M. wind decreased to strong SE. gale with very heavy squalls; confused sea from SE., S. and SW., causing vessel to labor heavily; barometer steady.
SE.-SW.	H. R. R.	Q. P.	Squally, wind decreasing to fresh breeze.
W. by N.	H.	C.	Fierce gale with terrible hail squalls moderating slightly; sea very heavy.
WNW.	H.	R.	Whole gale with terrible rain; fearful sea.
SE.	H.	O. Q. R.	
S.	R. H.	C.	
W.	H.	O. Q. U.	
W. by S.	H.	C.	
S.	H.	Q.	At 2 A. M. wind SE. by E. [illegible]
NNW.	R.	H.	Wind and sea decreasing; strong hail squalls.
			Barometer rising.
NNW.	H.	Q.	Weather improving slowly.

November 24, 8 A. M., Local Time.



Reports; November 24, 8 A. M., Local Time.

No.	Vessel.	Barometer.	Sea— From:	Sea— State of:	Weather.	Remarks.
[illegible]	Angloman, Br. ss.	[illegible]	NW.	R.	C.	Weather moderating fast; kept ship on her course again.
[illegible]	Bohemia, Ger. ss.		NNW.	L. R.	O.	
11	Chester, Dutch ss.	[illegible]	SW.	H. R. L.	O. U. R. Q.	Since 4 A. M. wind increasing and backing south.
21	[illegible], Br. ss.	[illegible]	SE. & SW.	H. C.	R. C.	Barometer rising slowly from 4 A. M.; weather fine in [illegible]; confused sea from SE., S. and SW.; wind decreasing and [illegible]
[illegible]	Lucerne, Br. ss.	[illegible]	NW.	H.	R.	Terrific gale with tremendous sea; ship hove to [illegible]
[illegible]	Maryland, Br. ss.	[illegible]	SW.	H.	O. Q. R.	At 8 A. M. barometer at its lowest; wind [illegible] with violent squalls.
37	Mobile, Br. ss.	[illegible]	S.	R. H.	C.	
46	Potomac, Br. ss.	[illegible]	NNW.	H.	O. Q. U.	
47	[illegible], Br. ss.		NW.	H.	Q.	
[illegible]	Sarmatian, Br. ss.	[illegible]	S.	H. C.	R. D.	At [illegible] A. M. the wind was E. by N., force [illegible]; at 8 A. M. variable, [illegible] increased to force [illegible] at 10 A. M.
[illegible]	Virginian, Br. ss.	[illegible]	NNW.	H.	Q.	Weather slowly improving.

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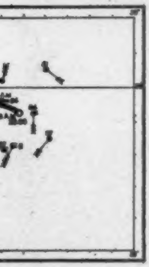
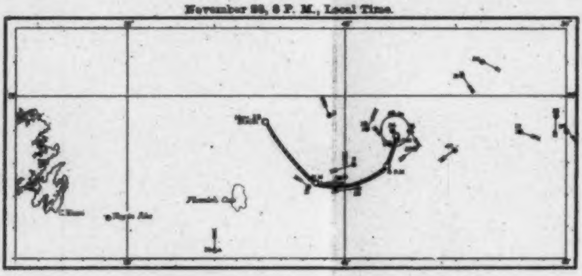


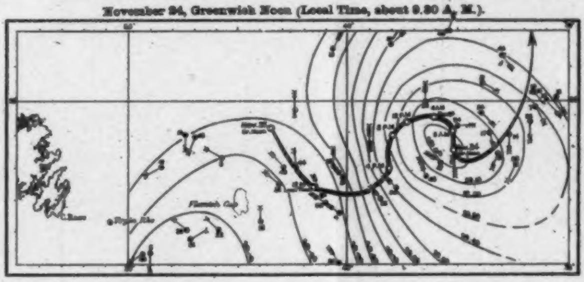
November 23, 6 P. M., Local Time.



Reports; November 23, 6 P. M., Local Time.

No.	Vessel.	Barometer.	Sea— From:	Sea— State of:	Weather.	Remarks.
3	Anglesean, Br. ss.	[illegible]	NNW.	V.	U.	At 6 p. m. the wind fell light then jumped to the N'd and freshened. At 7.30 commenced to blow with terrific force from NNW., sea rising fast. At 8 blowing a hurricane, sea rising mountains high.
6	Bohemia, Ger. ss.	[illegible]	NW.	L. H.	O.	At 7 p. m. wind NE., 9. Heavy seas breaking over the whole ship, smashing the sides, boats and ventilators. Sea mountainous; oil in use but of no effect.
11	Chester, Dutch ss.	[illegible]	S-W.	H. S. R.	O. Q.	At 5.15 p. m. barometer [illegible]. The wind after it had backed toward east jumped to WSW. and increased rapidly. Wind and tremendously high sea.
12	Chester, Br. ss.	[illegible]	SE.	H.	O.Q.U.R.	Whole gale, violent squalls, ugly appearance.
21	Havana, Br. ss.	[illegible]	SE.	H.	O. R. Q.	Hurricane squalls of rain at times; heavy SE. sea running with an under swell from south.
22	Kansas City, Br. ss.	[illegible]				
26	La Hesbaye, Dutch ss.	[illegible]	SW. by S. to NW.	R. B.	U. Q.	Wind and sea increasing.
31	Lord Charlemont, Br. ss.	[illegible]	NW.	H.	O.	Gale increasing with fierce squalls and mountainous sea.
33	Lucerne, Br. ss.	[illegible]	W.	H.	R.	Weather same as at 4 p. m.
34	Maryland, Br. ss.	[illegible]	SE.	H.	O. Q. R.	Heavy squalls with rain from SE. and SSE.
37	Mobile, Br. ss.	[illegible]	S.	B. H.	C.	Barometer fell till [illegible] p. m., [illegible]; sudden lull in the wind then shifted to SW., freshened rapidly and barometer rose quickly.
46	Potomac, Br. ss.	[illegible]		H.	O.Q.U.R.	Gale increasing rapidly; frequent hurricane squalls with heavy rain; high sea; weather dark, gloomy and oppressive.
47	Rialto, Br. ss.		SW.	H.	Q.	
52	Sarmatian, Br. ss.	[illegible]	WSW.	H.	B.	From 4 till 6 p. m. wind SE. by S., force 6.
53	Standard, Ger. ss.	[illegible]	NNW.	H.	O. R.	Weather as at 4 p. m.
54	Templemore, Br. ss.	?	SE., S. and NE.	A.		From 4 till 7.30 wind NE., force 6 to 7, with rain. It then cleared off and at 7.45 the wind was north, 3. From then till 8 p. m. almost calm, barometer steady at its lowest reading. Apparently center of storm.
56	Virginian, Br. ss.	[illegible]		Confused.	●	At 4.30 p. m. the rain stopped and weather cleared up, showing a white looking sky; heavy banks of dull lead-colored clouds round the horizon with jagged edges; also some detached clouds coming from the north at a furious rate. At 5 p. m. wind came from the north with force 10; sea one mass of white foam and seemed to be running in all directions. At 6 p. m. sea furious from the north.

November 24, Greenwich Noon (Local Time, about 9.30 A. M.).



No.	Vessel.	No.	Vessel.	No.	Vessel.
1	Aller, Ger. ss.	20	Gut Heil, Ger. ss.	41	Ottoman, Br. ss.
3	Anglesean, Br. ss.	21	Havana, Br. ss.	43	Paula, Ger. ss.
4	August Korff, Ger. ss.	22	Kansas City, Br. ss.	44	Polaria, Ger. ss.
5	Baltic Standard, Br. ss.	26	La Hesbaye, Dutch ss.	45	Pomeranian, Br. ss.
6	Bohemia, Ger. ss.	27	Lahn, Ger. ss.	46	Potomac, Br. ss.
7	British Empire, Br. ss.	28	Lancastrian, Br. ss.	47	Rialto, Br. ss.
8	Buenos Ayrean, Br. ss.	31	Lord Charlemont, Br. ss.	48	Roman, Br. ss.
11	Chester, Dutch ss.	33	Lucerne, Br. ss.	49	Runic, Br. ss.
12	Chester, Br. ss.	34	Maryland, Br. ss.	51	St. Pancras, Br. ss.
14	Colorado, Br. ss.	35	[illegible], Br. ss.	52	Sarmatian, Br. ss.
15	Edam, Ger. ss.	36	Mississippi, Br. ss.	54	Templemore, Br. ss.
16	Elbe Marie, Ger. ss.	37	Mobile, Br. ss.	55	[illegible], Br. ss.
17	Europa, Br. ss.	38	[illegible], Br. ss.	56	Virginian, Br. ss.
18	Excelsior, Br. ss.	39	New York, Amer. s.	58	Weser, Ger. ss.
19	Furnessia, Br. ss.	40	Numidian, Br. ss.		

[From the Pilot Chart of the North Atlantic Ocean, March, 1895.]

The area selected for representation covers the region where the winds were violent, changeable, and shifting rapidly. As the position of each vessel and the direction and force of wind experienced by her at the hour of observation are shown on each chart, these data are omitted from the columns. Extracts from reports furnished are given in the text and afford a good study of the storm. The large number of reports received has permitted the plotting of the storm centre at eight separate hours. As the storm disappeared rapidly after noon (local time), Nov. 24, it has been deemed sufficient to merely illustrate its track from the position of the centre given on the last chart, Nov. 24, Greenwich noon.

ERRATA. — In the table on page 334, January number, omit the zero marks after the words *Below*, *Above* and *Range*, at the top of the table, and add the word *normal* in the first two cases, so that the headings shall read as follows: *Below Normal; Above Normal; Range.*

BIBLIOGRAPHICAL NOTES.

BLUE HILL METEOROLOGICAL OBSERVATIONS FOR 1893.

Observations made at the Blue Hill Meteorologcal Observatory, Massachusetts, U. S. A., in the year 1892, *under the Direction of A. Lawrence Rotch, A. M.* With appendices containing *Studies of the Short Wave-like Pressure Oscillations* and of the *Average Weather Conditions in a Period of* 26.68 *Days.* Annals of the Astronomical Observatory of Harvard College, Edward C. Pickering, Director. Vol. XL., Part III. 4to, Cambridge, Mass. Pp. 143–205, pls. 3.

In the introdution to the Blue Hill observations for 1893 Mr. A. Lawrence Rotch makes the announcement that during the year the Metropolitan Park Commission, constituted by an Act of the Massachusetts Legislature, has taken the whole of the Blue Hills, including the sixty-seven acres around the Observatory which were bought to protect the latter from encroachment, as a public reservation for park purposes. The Park Commission has, however, made a statement that the Observatory will not be interfered with in any way. It is, of course, of very great importance that the observations should be continued at Blue Hill as heretofore, and meteorologists the world over would count it as a distinct loss to the science should anything occur to prevent this. We understand that the Harvard College Observatory is very desirous of securing some portion of the summit of Blue Hill in order to carry out there certain astronomical work which is no longer possible in Cambridge, owing to the increase of

electric street-car lines and of electric lights in the streets, and we believe that steps have been taken to secure from the State a lease of a portion of the summit for this work. There can be no doubt that such an arrangement, by which both astronomical and meteorological work would be carried out at Blue Hill, would result in distinct gain to astronomy, and would also ensure the continuance of the valuable series of meteorological records made during the past nine years at the Blue Hill Observatory.

The work of the Observatory during 1893 was carried on, under the direction of Mr. Rotch, by Mr. S. P. Fergusson and Mr. W. H. Fergusson. Mr. S. P. Fergusson has continued the comparisons of different types of anemometers. Mr. H. Helm Clayton has been devoting much of his time to the study of the upper air around cyclones and anticyclones, as shown by the cloud observations at Blue Hill, and his results will be published as Part IV. of Vol. XXX. of the Annals of the Harvard College Observatory. Mr. W. H. Fergusson has investigated the connection between the magnetic and meteorological elements in the 26.68 day period.

The present volume contains, as usual, the eye observations made twice a day (8 A. M. and 8 P. M.), arranged in the international form; a summary for the year; a table of the duration of sunshine, of the mean and maximum velocity of the wind, and of the number of hours the wind blew from the different points of the compass; a summary of the valley station; the hourly precipitation, and annual summary of hourly precipitation; the number of times precipitation occurred during each hour; a summary of the visibility of Nobscot, Wachusett, and Monadnock Mountains, distant respectively 20, 44, and 68 miles; the cloud observations, made thrice daily, and the hourly amount of cloud for each day, month, and the year.

In Appendix E, Mr. Clayton presents an interesting Study of the Short, Wave-like Oscillations shown by the Barograph at Blue Hill Observatory. Examples of such oscillations were given in the volumes of Blue Hill observations for 1886 and 1887, and since then, Mr. Clayton has collected for discussion all the occurrences that could be readily distinguished since May, 1885. In this collection, the rises and falls accompanying thunderstorms were omitted, except in cases where wave-like oscillations were observed in other parts of the same day. It is found that the number of days of occurrence of these oscillations is irregular, the figures for the successive years being as follows: 1886, 4; 1887, 7; 1888, 6; 1889, 4; 1890, 14; 1891, 8; 1892, 7; 1893, 11. The number of waves occurring during each month for the six years, beginning with January, 1886, is as follows: January, 9; February, 5; March, 12; April, 15; May, 5; June, 5; July, 4; August, 3; September, 3; October, 7: November, 2; December, 8. It appears, further, that the largest number of waves is observed when the wind is northeast, and the smallest number when the wind is southwest; and that the wind velocities attending the waves are usually above the normal. The mean ranges of the barometer in the waves for the three principal winds, were: N.E., .05 inch; W., .07 inch; S.E., .05 inch.

The waves usually occur within well-defined cyclones, and are most frequent on the northeastern side of cyclones moving northeastward near the

Atlantic coast; the wind is found to oscillate both in direction and velocity synchronously with the barometer. Rain or snow falls in connection with the waves in the great majority of cases, and in the most marked waves there was recorded a decided increase in the intensity of the rainfall with the passage of the crest of the wave. March and April are found to be the months of maximum frequency of occurrence, and there is a minimum of frequency in the autumn. The waves are more frequent at night than during the day, the hours of maximum frequency being about 5 A. M. and 6 P. M. Slight, indistinct undulations of the barometer, which appear to be of the same nature as the larger waves, are common, and appear in all kinds of weather.

A comparison of barograph records from other stations in New England shows that these pressure waves can in most cases be followed, entirely across the district, and Mr. Clayton has been able to draw charts showing the hourly progression of the waves from west to east. These charts are very similar in appearance to charts showing the progression of thunderstorms across country, the isobaric lines showing, in several cases, the convexity generally noted in thunderstorms. The velocities of propagation of the waves range from 79 miles per hour to 30 miles per hour, the average for 12 cases being 44.5 miles.

Regarding the cause of these waves, which were so carefully studied by von Helmholtz, it appears from the investigations of that eminent physicist that they are probably the result of great atmospheric waves, like the waves in the ocean. Mr. Clayton gives several extracts from von Helmholtz's conclusions, as presented by him in a paper before the Royal Prussian Academy of Sciences in Berlin, July 25, 1889. This paper was translated by Prof. Abbe in the Smithsonian Contributions to Knowledge. In view of the interest that is just now being taken in this subject of atmospheric waves, especially in connection with the formation of clouds, we give the following quotations from von Helmholtz: —

"As soon as a lighter fluid lies above a denser one with well-defined boundary, then evidently the conditions exist at this boundary for the origin and regular propagation of waves, such as we are familiar with on the surface of water. This case of waves, as ordinarily observed on the boundary surfaces between water and air, is only to be distinguished from the system that may exist between different strata of air, in that in the former the difference of density of the two fluids is much greater than in the latter case. . . . Since the moderate winds that occur on the surface of the earth often cause water waves of a meter in length, therefore the same winds, acting upon strata of air of 10° difference in temperature, maintain waves of from two to five kilometers in length. Larger ocean waves, from five to ten meters long, would correspond to atmospheric waves of from fifteen to thirty kilometers, such as would cover the whole sky of the observer, and would have the ground at a depth below them less than that of one wave-length, therefore comparable with the waves in shallow water, such as set the water in motion to its very bottom. . . .

"Since the elevations of the air-waves in the atmosphere can amount to many hundred meters, therefore precipitation can often occur in them, which

then itself causes more rapid and higher ascent. Waves of smaller and smallest wave-length are theoretically possible, but it is to be considered that perfectly sharp limits between atmospheric strata having different motions certainly seldom occur, and therefore, in by far the greater number of cases, only those waves will develop whose wave-length is very long compared with the thickness of the layer of transition. The circumstances that the same wind can excite waves of different lengths and velocities will cause interferences to occur between the waves, and also higher and lower wave-summits to follow each other interchangeably."

Mr. Clayton's study of these atmospheric waves at Blue Hill promises to develop some interesting facts regarding these surges, and it is to be hoped that he will continue his researches in this direction.

Mr. W. H. Fergusson, in Appendix F, considers the Average Weather Conditions in a period of 26.68 days. He has introduced a set of curves, including the magnetic curve, the mean barometer, wind velocity, temperature cloudiness, humidity, precipitation, etc., and finds that there is a general correspondence in the sweep of these curves. The magnetic curve used is that given by Prof. F. H. Bigelow in this Journal for September, 1893, and the other curves are derived from the meteorological conditions recorded at Blue Hill Observatory during fourteen periods, beginning with Dec. 29, 1892.

LEY'S CLOUDLAND.

W. Clement Ley. *Cloudland; A Study on the Structure and Characters of Clouds.* 8vo. London, Stanford. 1894. Pp. 208. Numerous colored plates, photographs, charts and diagrams. Price, 7s. 6d.

Ley has so long been recognized as an authority on clouds, and his writings have so much influenced thought on this subject, that the knowledge that he was preparing a book on clouds had led meteorologists interested in this matter to look forward with expectation to its appearance. Its appearance was long delayed by the illness of the author and even now is completed by C. H. Ley, as indicated by the preface. To the writer the appearance of the book is both a disappointment and a pleasure. It is a disappointment first, because the book is not larger and does not give more of the author's large fund of information; and second, because it is too original for a popular treatise for which it is evidently intended, and gives no key whatever by which the reader not versed in the science may connect the information derived from this book with the information derived from other sources.

It seems a great pity that after the long struggle to obtain a system of cloud names which might be recognized as descriptive of certain cloud forms in every part of the world, and after the International Meteorological Congress had set the seal of its approval on the system of Abercromby and Hildebrandsson, that this nomenclature should not even be mentioned in the

book. An entirely original system of nomenclature is introduced, and the popular reader who learns his terminology from the book will find himself entirely out of line with general usage and unable to compare his own observations with those of others.

But aside from the confusion which it may cause, and viewed as a scientific treatise, the book is an important contribution to the subject. The novel nomenclature finds its excuse in the effort to classify clouds according to their natural causes, which usually in the end comes to be the accepted basis for all classification. In the reviewer's opinion, however, our knowledge of the causes of particular cloud forms is not yet sufficient for a final classification on this basis, though the present attempt is an important contribution to the subject.

The clouds are classified under four heads, namely: clouds of radiation, clouds of interfret, clouds of inversion, and clouds of inclination. "Clouds of interfret are caused by the interaction of more or less horizontal currents of different velocities or directions; clouds of inversion are caused by condensation in an upward direction in more or less vertical currents, although the shape of the clouds of the latter class may be affected by differences of velocity and direction in the horizontal movements of the air."

"When, from any cause, a layer of air containing water vapor has been carried to a very high altitude into layers of air which are very rarefied and of very low temperature, condensation will commence as soon as this layer has been sufficiently cooled, and this will be helped by interfret action between it and the surrounding layers. The minute water particles thus formed immediately fall by their own weight through the cold layers, and are almost as immediately frozen into ice dust. If their fall still continues, they are carried through currents which grow gradually warmer but more gradually slower and slower, owing to friction, until they experience a temperature which forbids their existence as ice particles, and converts them first into water particles, and then, probably very soon, into their old form of water-vapor. The cloud thus formed will obviously present a curved form to the eye of an observer, for each portion will lag behind the more rapidly moving portion above. . . . The process above described is that of the simplest type of inclination cloud and it is evident that this process may be much complicated."

The separate cloud forms are arranged under these four heads and mostly given new names, as, for example, *Stratus-Maculosus*, for the form corresponding with the Alto-Cumulus of the International nomenclature. But a number of cloud forms not previously or generally recognized are described and named, as *Stratus-Castellatus* for turreted clouds, *Stratus-Lenticularis* for lenticular clouds, and several others which well deserve the attention of observers. The suffix *mammatus* was introduced by Ley and is now generally adopted to describe the under surface of clouds when they appear to hang in festoons or like *mammæ*, but the explanation of their origin given by Ley seems to the reviewer much less probable than that given by W. S. Jevons and C. Clouston who first described them. According to Jevons and Abercromby, the mammated appearance of the cloud is deter-

mined by the descent of the heavier portions of the cloud formed in a rapidly ascending current. But Ley explains their origin as follows: "Where the upper portion of a local inversion cloud spreads out horizontally, if the conditions are such that the layers of air are here somewhat less rapidly moving than the layers immediately below, and if they have also a temperature and relative humidity greater than those of the subjacent layers, Interfret comes into play in the reverse order of vertical distribution to that which it most commonly occurs. On rare occasions the result produced may be even compared to a large Turret cloud upside down, and the appearance is truly stupendous." Furthermore, Ley's explanation of clouds of the Alto-Cumulus type as due to "Interfret" does not appear entirely satisfactory though no doubt this is one of the causes in its origin. Ley's strong point is his explanation of the association of the cloud forms with the succeeding weather, and in this respect his treatise seems admirable. The latter part of the book is devoted to winds, but in this there appears to be little distinctively original. The photographs are good, but in this connection it is well to call attention to an inherent difficulty in understanding cloud photographs without the author explains them, namely, in some photographs the sky appears black and the clouds white, while in others the sky appears white and the clouds black, so that it is impossible sometimes to tell which is cloud and which sky. Both kinds appear without explanation in Ley's book, and though the photographs are good it is probable that an inexperienced observer would find it difficult to determine which is cloud in the illustration on page 96, and perhaps also in other places.

H. H. C.

NEW PRESSURE CHARTS OF THE NORTH ATLANTIC.

G. Rung. *Répartition de la Pression Atmosphérique sur l'Océan Atlantique Septentrional d'apres les Observations de* 1870 *à* 1889, *avec la Direction Moyenne du Vent sur les Littoraux.* 16 in. x 20 in. Copenhagen, 1894. 8 pp. text and tables; 14 charts.

In the introduction to the present atlas, the author, Capt. Rung, of the Danish artillery, Assistant Director of the Danish Meteorological Institute, states that his object in preparing these new charts of pressure distribution over the North Atlantic was to include in the area studied the oceans adjoining the North Atlantic, especially the Arctic, and also to give data for every month of the year. The charts hitherto published of the North Atlantic, *e. g.*, those in the *Atlas zum Segelhandbuch für den Atlantishen Ozean*, of the Deutsche Seewarte, and the *Charts Showing the Mean Barometrial Pressure over the Atlantic, Indian and Pacific Oceans*, published by the Meteorological Council, include only the months February, May, August, and November, and further, do not extend, as in the case of the English charts, north of 60° N. Lat. and as in the case of the German ones, north of 65° N. Lat. The Arctic low pressure area is thus to a great

extent unrepresented. One of the chief reasons, if not the chief reason, for omitting that part of the ocean north of latitude 65° N. was, of course, the lack of reliable data from the far northern stations. Since 1872, when the Danish Meteorological Institute was founded, it has organized the stations in Greenland and Iceland, and it is therefore only very recently that regular and reliable records have been accessible for those districts. The eight years' *Cartes synoptiques Journalières du Temps*, published by the Danish Institute and the Deutsche Seewarte, have now made it possible to determine the mean atmospheric pressure at a sufficient number of stations, over the North Atlantic and Arctic Oceans, to allow accurate mean, annual, and monthly pressure charts to be drawn.

The daily Dutch and German charts have furnished data for the period from Dec. 1, 1880, to Nov. 30, 1889, with a break from Sept. 1, 1882, to Aug. 31, 1883, the time of the International Polar Expeditions. The data for the missing months were obtained from the English Meteorological Council's *Synchronous Weather Charts of the North Atlantic and the Adjacent Continents for Every Day from Aug.* 1, 1882, *to Aug.* 31, 1883. The nine-year monthly means were completed by means derived from morning observations made during the same period of nine years at stations on the adjacent continents. Isobars were then drawn for every millimeter. As these nine years were too few to furnish satisfactory monthly means, the means thus found were reduced to a period of twenty years, and at the same time the daily means were obtained from the morning means. This was done as follows: for the period of twenty years, the years 1870–1889, were chosen because Buchan's *Report on Atmospheric Circulation*, of the "Challenger" Expedition, furnished the best available data for 1870–1884, the data for the years 1885–1889 being obtained from other sources. The monthly means for certain coast stations of America and Europe were determined for the two periods, *i. e.*, the morning means for the nine years and the daily means for the twenty years, and the differences which existed between these means were then found. These differences were then entered on a chart, and curves were drawn, which gave the necessary correction to be applied in order to change all the morning means for the nine years into the diurnal means for twenty years. In this way the values were obtained for the eighty stations, which served as a basis for the final charts. These eighty stations were chiefly points in the Atlantic and Arctic Oceans, a few being in Greenland, Canada, and Labrador. In addition to the marine stations, the monthly means for twenty years were determined, from the best sources, for 92 additional stations on land. All the pressures are reduced to sea level, standard gravity, and temperature of 0°C.

Besides the pressure, the mean direction of the wind at 55 coast stations has been entered on the charts. An interesting supplementary chart gives graphic colored representations of the annual curve of pressure, showing the variation month by month, for a series of 40 points, chiefly on the Atlantic. Variations of pressure below the normal are colored green; those above, red. The curves are so arranged that curves for the same latitude are in vertical rows, while curves for the same longitude are in horizontal rows.

These curves furnish much material for study, and clearly show the greater range of pressure in the higher latitudes.

The atlas comprises thirteen charts, besides the one just referred to, *i. e.*, one chart for each month and one for the year. The isobars are drawn for every millimeter, and pressures below 760 mm. are colored blue; those above, red. The actual pressures, which furnish the basis for the isobars, are entered in nearly all cases on these charts.

Capt. Rung and the Danish Meteorological Institute have done meteorologists a great service in publishing this valuable atlas, which gives data in regions not hitherto charted in this manner. The cartographic work is admirable; and the charts, being unbound, can the more readily be used as illustrations for class work.

THERMOMETRY.

Abhandlungen ueber Thermometrie von Fahrenheit, Réamur, Celsius. (1724, 1730–33, 1742). Herausgegeben von A. J. von Oettingen. 12mo. Leipzig, 1894. 140 pp. 17 figs. Price 2 marks 40 pf.

The last two or three years have brought meteorologists several reprints of important works bearing on their science, which were originally written long before the modern development of meteorology had begun. Dr. Hellmann has given us reprints of Reynmann's "*Wetterbuechlein,*" of Pascal's "*Récit de la Grande Expérience de l'Equilibre des Liqueurs,*" and of Luke Howard's *On the Modifications of Clouds.* Mr. Symons has secured the publication of *Merle's MS.*, 1337–1344, *The Cobham Journals* and *Cowe's Meteorological Journal,* and, quite recently, of *Theophrastus on Winds and on Weather Signs.* It is fortunate that students are provided with some of these old writings, for without a foundation of the pioneer works in a subject the superstructure of modern learning cannot be very firm, and to have these reprints put before us in an inexpensive and attractive form is certainly a great boon.

In a line with what has been done by Dr. Hellmann and Mr. Symons, comes a new series of *Classics of the Exact Sciences* (the German title is *Ostwald's* "*Klassiker der Exakten Wissenschaften*"), published by Wilhelm Engelmann of Leipzig. The idea of this series is to reprint in German certain of the early writings of importance in the various sciences in a cheap and convenient form, for the use of students. The editorship is at present in the hands of Prof. emer. Dr. Arthur von Oettingen, *Privat docent* in Leipzig, and the branches which are included in the plan are Mathematics, Astronomy, Physics, Chemistry, and Physiology. Quite a number of volumes have already been issued, and three of the most recent ones have lately come to our desk. Of these the one numbered 57, under the head of Physics, is of especial interest and importance to the meteorologist.

The present volume contains reprints of all the writings on thermometry which have come to us from Fahrenheit, Réaumur, and Celsius, together

with biographical and explanatory notes. There are five papers by Fahrenheit: I. Experiments on the Boiling Point of Certain Fluids. II. Experiments and Observations on the Freezing of Water in a Vacuum. III. Specific Gravities of Certain Substances determined at different Times and for Different Purposes. IV. Description and Use of a New Areometer. V. Description of a New Barometer. These papers were all originally published in the *Philosophical Transactions*, of London. Gabriel Daniel Fahrenheit was a German, the son of a merchant of Dantzig, in which city he was born May 14, 1686. His father moved to Amsterdam, and there the son became a worker in glass, and as a part of his trade made meteorological instruments. He soon became well known, and was elected a member of the Royal Society of London, in which city he spent a good deal of time. He died Sept. 16, 1736, in Amsterdam, at the age of fifty. Fahrenheit's writings were in Latin. It was he who first used mercury in a thermometer, and settled down to two fiducial points, those of freezing and boiling water. The division of the scale into 180 degrees was purely accidental. Fahrenheit also noticed that the boiling point of water varied with the pressure.

Réaumur was born in La Rochelle, in 1683, and died in 1757. He first studied law, but soon turned away from that and in 1708 became a member of the Paris Academy of Sciences. His writings on scientific subjects were numerous. In his thermometric work he knew nothing as to what Fahrenheit was doing, but went on independently. He used only one fiducial point that of freezing, and his experiments were carried on with alcohol instead of mercury. The present so-called Réaumur scale is quite different from that used by Réaumur himself. Réaumur's papers reprinted in the volume under discussion are as follows: I. Rules for the Construction of Thermometers with Comparable Scales. II. Second Treatise on the Construction of Thermometers with Comparable Scales. III. On the Volume of Liquid Mixtures; Investigation of the Question whether two Liquids mixed together have a Volume equal to the Sum of the Volumes of the Separate Parts of the Mixture, or whether the Resulting Volume is greater or less than the Sum of the Separate Volumes. These papers were published in the Memoirs of the Paris Academy of Sciences.

Celsius was born Nov. 27, 1701, in Upsala, and died there April 25, 1744. He was professor of Astronomy in his native city from 1730 on. His writings were on astronomical subjects, with some notes on meteorology and terrestrial magnetism. The only paper by Celsius on thermometry is entitled, "Observations of Two Fixed Points on a Thermometer." It is probable that Christin, in 1743, first used the 100-degree mercurial thermometer, now generally known as centigrade, although it is sometimes wrongly called the Celsius thermometer; but there is still considerable disagreement as to the exact situation regarding priority. Celsius himself fixed his freezing point at 100°, and his boiling point at 0°.

We are glad to call attention to this new publication, which many persons interested in thermometry will be glad to read. Its low price, 2 marks and 40 pfennigs, places it within reach of all. We notice one rather serious misprint. On page 126, in the notes on Fahrenheit, the statement is made

that Fahrenheit discovered the "*Unabhaengigkeit des Siedepunktes vom Luftdrucke*," whereas the first word should read *Abhaengigkeit*, for it was this investigator who, in his paper on the Description of a New Barometer (1724), showed that the height of the mercury column of his thermometer at the boiling point of water varied with the pressure of the atmosphere. It was in this paper that Fahrenheit said, in speaking of the thermometer, that by this drifting of the boiling point at different pressures, the thermometer showed the pressure of the atmosphere as well as, if not better than, the barometer.

OTTO VON GUERICKE'S MAGDEBURG EXPERIMENTS.

Otto von Guericke's neue "Magdeburgische" Versuche ueber dem leeren Raum, 1672. Aus dem Lateinischen uebersetzt und mit Anmerkungen herausgegeben von Friedrich Dauneman. 12mo. Leipzig, 1894. 116 pp. 15 figs. Price, 2 marks.

The present little volume is No. 59 of the series of reprints published by Engelmann, of Leipzig, under the title, *Ostwald's Klassiker der Exakten Wissenschaften*, of which series we have just reviewed No. 57. It contains a translation from the Latin of the third and most important book of Guericke's work, *De Vacuo Spatio*, which contains in all seven books, was completed by the author on March 14, 1663, and published in 1672, in Amsterdam. The present is, we believe, the first translation of the original ever made, and is therefore of special interest. The translator has added a short account of Guericke's life and work, together with explanatory notes, from which we take the following facts as to the physicist's life.

Otto von Guericke was born Nov. 20, 1602, in Magdeburg, of a noble family. At the age of fifteen, young Guericke entered the University of Leipzig, and later studied law in Helmstädt, Jena, and Leyden. In the latter place he became interested in physics and mathematics. After a journey in France and England, he returned to Magdeburg. The Thirty Years' War obliged him to fly from the city, and he became an engineer in the army of Gustavus Adolphus for a time. He afterwards returned to Magdeburg, and in 1646 was elected one of the four burgomasters. Guericke became deeply interested in science, and especially in the question, which was then much agitated, regarding the vacuum. In the year 1654, at the parliament in Regensburg, a Capuchin friar named Valerianus gave Guericke his first information as to Torricelli's discovery of the so-called Torricellian Vacuum, and it is in connection with his experiments with a vacuum that Guericke has become famous. He also did a good deal of valuable investigation in magnetism and electricity; indeed, he made what was probably the first machine for the production of electricity. Guericke died May 11, 1686, in Hamburg.

The third book of the work, *De Vacuo Spatio*, takes up the subjects of the nature and properties of the atmosphere; the production of a vacuum; ex-

periments with fire, light, sound, etc., in a vacuum; the pressure of the atmosphere and its measurement; the famous experiment with the "Magdeburg hemispheres"; the variations of pressure, and the decrease of pressure with altitude, etc. The first chapter, on the Origin, Nature, and Properties of the Air, contains several striking passages. The effect of heat in expanding and of cold in contracting the air; the pressure of the air, which is greater in the lower strata than in the upper, and acts alike on everything, varying a little from day to day; the pressure of more water vapor in the lower air than in the upper, etc., are noted and commented on. Certain experiments on the sudden expansion of air showed Guericke that he could produce artificial clouds and fog when the air was no longer able to contain all its moisture as vapor. Chapters XVII., XVIII., and XIX. are especially noteworthy, for in them Guericke describes his experiments with a water barometer, he having been the first to use such an apparatus to foretell coming changes of weather. His description of how he gradually lengthened the tube in which the water rose, until the top was on a level with the fourth story of his house, is most interesting. With the shorter tubes he found that, when a vacuum was produced at the top of the tube, the water rose all the way up. Finally, when he went up into the fourth story and made the experiment, he found that the water did not reach the top of the tube, but remained at a certain height in the tube. This experiment was repeated several times, and each time the water stood at the same height. Careful observation soon showed that this height varied from day to day, and Guericke therefore concluded that "the abhorrence of a vacuum depends on the pressure of the atmosphere, which, when there is an empty space, urges the water to enter this space and fill it up, to a height corresponding to this pressure. . . . That the rise of the water is produced by the pressure of the outer air is very evident from the fact that the water does not always keep the same height. . . . The height of the water in the tube does not depend on Nature's abhorrence of a vacuum, but on the balance between the weight of the water column and that of the atmosphere."

In this connection Guericke distinctly states that a column of air with a base the size of a penny, reaching to the top of the atmosphere, exerts a pressure just equal to that exerted by a column of water, with the same base, and 34 feet high. His observations on the action of these water columns led Guericke to the conclusion that water could not be raised from a well by means of a pump more than 34 feet. In order to make his barometer a definite means of forecasting the weather, he arranged a small wooden figure, which rose and fell with the rise and fall of the water, and which pointed to a scale on which the heights were marked. By means of this very crude barometer, he foretold a very severe storm which occurred in 1660.

Chapter XXXVII. contains an account of a spirit thermometer, which Guericke so arranged that a little figure of an angel was suspended alongside of the tube and moved up and down with the ascent or descent of a float on top of the spirit, the float and the figure being connected by a thread which passed over a pulley at the top of the tube. The figure was ar-

ranged to point to the thermometer scale, and thus to indicate the temperature.

The illustrations in this book are quaint and interesting, especially the one showing the sixteen horses trying to pull apart the two "Madgeburg hemispheres."

KRETZER'S LIGHTNING RECORD.

This is a collection of nearly two thousand detailed descriptions of accidents caused by lightning in the United States from 1891 to 1895. The sources of information were 22 of the leading newspapers. A very complete index of the features of lightning accidents is given, the object of the author being to show exactly what has happened and may happen in connection with lightning. A request is made for reports, as detailed as possible. The book is published privately by Mr. H. F. Kretzer, 720 S. Seventh Street, St. Louis, Mo. A. M.

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